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In the Pecos Viaduct article in our last issue, omission was made, owing to a printer's error, of the names of Mr. J. T. Mahl and Mr. H. D. McKee, Resident Engineer and Foreman of Erection, respectively, for the Phoenix Bridge Co., which had the contract for the iron work and the erection of the bridge.

Plans for a tunnel for connecting East Boston with Boston proper have been prepared by City Engineer Wm. Jackson. One plan calls for a single tunnel designed for two street car lines and a 10-ft. footway, and about 4% approaches. This tunnel would be about 5,000 ft. long, and cost, including $710,000 land damages, about $3,315,000. The second plan contemplates two tunnels, each provided with a single street car line and a 6-ft. footway, with same length of tunnel. The cost for this plan would be $3,996,000, including land damages as before. Both plans call for passenger elevators at both sides of the water. A third plan calls for the single tunnel, with three sets of passenger elevators and three sets of car lifts substituted for the inclined approaches. This would reduce the tunnel length to 2,500 ft., and the total cost to $2,430,000. Four other plans are also submitted varying in details of width, operations and cost. No borings have been yet made owing to a lack of appropriations, but the material is believed to be gravel or clay. The plans are now before the Mayor and city authorities. Iron tunnels, brick-lined, and provided with shields or compressed air plant, are apparently proposed.

A fresh start will be made in the attempt to secure a new water supply for Jersey City. On Jan. 5 the Board of Street & Water Commissioners rejected "any and all pending proposals for a new water supply." The only formal bid was from Moffett, Hodgkins & Clarke, New York city. The substance of this bid, and of the informal proposals, was given in our issue of Nov. 24, 1892. The bids were received on Nov. 21, 1892.

Diamond smokestacks are being applied to the latest fast passenger engines of the Union Pacific Ry., in preference to the extension front smokebox. The fuel used is Wyoming lignite from the company's mines, and throw sparks badly, and when netting or perforated plates were used sufficient to check the sparks, the engines would not steam freely. With the diamond stack, larger nozzles are used, which reduces the fuel consumption, and much better results are obtained.

The most serious railway accident of the week was a collision Jan. 6 on the New York Central & Hudson River R. R. at 147th St., New York, near the Mott Haven yard. A light engine running tender first was run into by a southbound local train of the Harlem line. The fireman of the light engine was killed, being thrown under the tender as he was about to jump.—In a snow plow wreck at Java, Wash., on the Great Northern Ry., Jan. 1, four men were killed.

The dam of the Pine Ridge irrigation reservoir, 60 miles above Fresno, Cal., gave way on Dec. 22, and much damage was caused. The dam was of masonry, across Stephenson Creek, and was 200 ft. long, 40 ft. thick at the base, and 37 ft. high. It was not completed to its full height, but stored about 30 ft. of water. The reservoir area was 2,100 acres. The flume to Dry Creek, 12 miles distant, was partially destroyed.

A trestle on the Yazoo & Mississippi Valley R. R., at Cannonsburg, Miss., gave way under a train Dec. 10, and we are indebted to Mr. M. Gilleas, General Superintendent, for the following particulars: The trestle had ten spans of 12 ft. 6 ins. span, eight of which were destroyed. The structure was six years old, of long leaf yellow pine. Bents 1 and 9 were frame bents, and the others four-pile bents. The wreck was caused by the train striking a mule, a horse and a colt 480 ft. from the bridge. The mule rolled under the cars after the engine had passed it, throwing the cars from the track about 90 ft. from end of bridge. The trucks were off the track when the cars struck the bridge, and bunched the ties, allowing the cars to fall through, thereby knocking down the framework of the trestle and letting the cars into the abyss. The structure failed on account of cars tearing up the track and breaking through the trestle. Five box cars and one baggage car were totally destroyed.

A temporary bridge across the Raritan River at Albany St., New Brunswick, N. J., was carried away by the ice on Jan. 2.

A locomotive boiler explosion occurred Jan. 4, at Brown's Crossing, Pa., on the Pennsylvania R. R. The crown sheet collapsed, owing, it is reported, to low water in the boiler. The engine was attached to a freight train. The engineman and fireman were fatally injured.—The boiler of a freight engine on the Louisville, New Albany & Chicago R. R., exploded Jan. 3, near Francesville, Ind., killing two men and fatally injuring a third.

A Baker heater in the smoking room of a sleeping car near Davenport, Ia., is reported to have exploded Jan. 2, but nobody was seriously injured.

An explosion occurred in the dope mill of the powder works of the American Forcite Co., near Lake Hopatcong, N. Y., Jan. 9. The machinery being run at too high a speed set the material on fire, and caused the explosion of some packed explosive near by.

Two flywheels, 15 ft. and 8 ft. diameter, at the Oliver & Roberts Wire Co.'s works, Pittsburg, Pa., burst Jan. 10. Two men were killed and others injured by flying pieces of iron. It is said that the engine speed is 120 revs. per minute, but that it was running slower than this at the time of the accident.

The right to build and operate a cable railway on Lexington Ave. in this city was sold at public auction on Jan. 6, to the Lexington Avenue & Pavonia Ferry Co., which is practically the same as the Houston, West Street & Pavonia Ferry Co. In addition to the 3% of gross receipts required by statute, the company named bid 0.½% if gross receipts, making the total payment to the city 3½%. The successful bidder is required to deposit a certified check of $1,000,000 to guarantee the building of the road within two years, $50,000 bonds, and to pay $6,245.20 in cash for advertising.

Rules for blasting in the vicinity of public roads on the construction of the Nilgiri Railway, India, (Eng. News, Aug. 4 and Oct. 6, 1892,) have been formulated for the direction of engineers and foremen by Mr. W. J. Weightman, Engineer in Chief. After the usual requirements for flagging the traffic, the use of none but plain, unshod, wooden tamping bars, the employment of special men to charge the holes, and the careful placing of the fuses, the following rule is given to insure safety in case of misfire: "If the number of shots counted does not correspond with the number of holes fired, the maistry (native foreman) should allow no one to go near for ten minutes, after which a single man should proceed with caution to search among the debris for the hole which has missed fire. He should not withdraw the charge, but insert another primer on the top of the original one, and fire as before.

The St. Lawrence River bridge bill has passed the House, at Washington, and there appears to be no doubt of its approval by the Senate. This bill would grant authority to the St. Lawrence Railway Co. to build a bridge across the river between New York and Canada, at such point as may be approved by the Secretary of War. The bridge must provide not less than 150 ft. clear headway at high water and have 500-ft. spans over the American and Canadian channels. All railways are to have equal rights and privileges in crossing the bridge and its approaches. It must be commenced in one and completed within three years.

New York city proposes to spend a little over $34,000,000 in the year 1893, according to the appropriations of the Board of Estimates. The Department of Public Works has allotted to it $3,014,000, and the Department of Parks gets $1,098,455. Street improvements in the 23d and 24th Wards require $350,472, and for street cleaning $2,203,135 is set aside. The total assessed valuation of real and personal property in the city of New York, for 1892, was $1,828,204,275, a net increase of $42,406,937 over the valuation of 1891.

A heavy freight engine for mineral traffic, with eight wheels, all coupled, has been built by the London & Northwestern Ry., of England, to the designs of Mr. F. W. Webb, Locomotive Superintendent. It is somewhat of an innovation, as hitherto engines with six wheels, all coupled, have been the standard type of freight engine in England. The springs are equalized, and the leading and trailing wheels have ½ in. lateral play. The boiler is 15 ft. 6 ins. long, with the tubes divided into two lengths by a combustion chamber. The Joy valve gear is used, and the valves are above the cylinders:

Cylinders	19½ × 24 ins.
Driving wheels, diam.	4 ft. 5½ ins.
Wheel base	17 " 3 "
Boiler, diam.	4 " 3 "
Boiler, length	15 " 6 "
Boiler pressure	160 lbs.
Tubes	number, 156; diam. 2⅛ ins.
Grate area	20.5 sq. ft.
Ratio of grate area to heat surf.	1 to 60.6
Heating surface, firebox	114.7 sq. ft.
" " combustion chamber	39.1 " "
" " tubes, front set	683.0 " "
" " tubes, back set	408.5 " "
" " total	1,245.3 " "
Weight on front pair of drivers	26,096 lbs.
" on main pair of drivers	28,448 "
" on third pair of drivers	26,096 "
" on rear pair of drivers	24,276 "
" of engine, total	104,916 "
" of engine and tender	160,916 "

Prohibition of the use of oil lamps in passenger cars is recommended in the report of the New York Railroad Commissioners, State of New York, in the following words:

Success has attended the effort to light passenger cars by gas. Last year the board set on foot inquiries as to the practicability and safety of the various systems in use, and the answers were assuring in both respects. Indeed, so practical, and so successful are the systems, and so widely have they been adopted, that a car in one of the first class or limited trains lighted by oil would be regarded as a relic of a past age. A sufficient reason why every passenger car, whether a palace car or ordinary coach, should not be lighted by gas, cannot be given. Economy should not be the prevailing consideration. Aside from the increased security from fire, the annoyance of dripping oil from lamps is avoided. The lighting of all passenger cars by gas is in line with the progress which has led to heating by steam instead of by stoves, and which is leading to automatic couplers instead of the link and pin, coupled by hand, and automatic brakes set from the engine rather than by men on the tops of cars at the risk of their lives. The prohibition of the use of oil by legislative enactment is desirable.

In the notes on transportation exhibits for the World's Columbian Exposition, in our issue of Dec. 29, 1892, it was stated that the Department of Transportation Exhibits had appointed Mr. Geo. DeHaven (General Passenger Agent of the Chicago & West Michigan, and Detroit, Lansing & Northern railways), of Grand Rapids, Mich., to make a representative collection of railway and steamship tickets and passes. It is desired especially to secure, by gift or loan, such tickets, time-tables, maps, etc., as have a special historical value. Large numbers of these are doubtless in existence in the hands of collectors, or of those men or their descendants who were identified with the railway or steamship business during the first half of the present century. It is hoped that the request for this material will reach the attention of persons possessing it, and that they will at once communicate with Mr. DeHaven on the subject. Suitable acknowledgement will be made, and the best care given to such loans. Informatoin as to the existence of such relics, and to whom to apply for them, will also be acceptable.

SEWAGE PURIFICATION IN AMERICA.

(Continued from vol. XXVIII., p. 611.)

Pullman, Ill.

The sewage farm at Pullman, like Pullman itself, has attracted much attention from engineers and others. A detailed description of the farm and the sewerage system was given over ten years ago in this journal,* less than a year after it was put in operation. Information regarding the present status of the sewerage system and sewage farm and other facts of interest have just been furnished us by Mr. Duane Doty, C. E., engineer for the Pullman company. This information has been combined with such of the matter previously published as is necessary to make the present article complete and intelligible in itself. Mr. Benezette Williams, C. E., was engineer for the whole system, and Mr. E. S. Chesbrough, M. Am. Soc. C. E., was consulting engineer.

Pullman is situated upon the west shore of Lake Calumet, 14 miles south of the Chicago Court House, where the Pullman interests have about 4,000 acres of land. It is reached by the Illinois Central Ry., and by recent annexation now forms a part of the city of Chicago. Lake Calumet is 3½ miles long by 1½ miles in width, and connects with Lake Michigan by the Calumet River. According to Mr. Williams' description in 1882, Lake Calumet is from 1 to 8 ft. deep, and connects with the Calumet River by a small channel. With varying stages of water the lake discharges into the river or water from the river into the lake.

The land upon which the city stands is blue clay, 90 ft. in depth, resting upon lime rock, and its surface is from 9 to 20 ft. above the lake level.

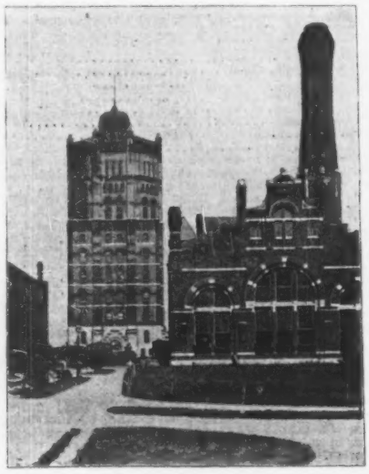


Fig. 56. Sewage and Water Pumping Station and Water Tower; Pullman, Ill.

Work was begun upon the town by the Pullman Palace Car Co. in May, 1880; the first family went there Jan. 1, 1881, and it now has a population estimated at 12,000. The present industries there are the Pullman Car Works, employing over 4,000 operatives, the Allen Paper Car Wheel Works, the Union Foundry, the Pullman Iron & Steel Works, the Standard Knitting Mills, the Paint Works, the Terra Cotta Works, the Screw Factory, and the Drop Forge & Foundry Co.'s Works. These various industries, with the car works, employ a total of about 5,500 operatives.

Oct. 18, 1881, the sewerage system was put in operation by starting the sewage pumps. Lake Calumet not being a suitable body of water to receive the sewage of Pullman, and an outlet to Lake Michigan requiring pumping through 6½ miles of pipe, it was decided to purify the sewage by broad irrigation, supplemented by intermittent filtration.

The separate system of sewerage was adopted to save expense and insure better results at the disposal works. The latter part of October, 1892, there had been laid 16,230 ft. of brick and 140,236 ft. of vitrified pipe storm sewers, the latter including drains for storm water from over 1,8[illegible] tenements. The brick storm sewers are laid in the middle of east and west alternate streets and discharge into Lake Calumet. The pipe storm sewers are of the following sizes and lengths:

Size.	Ft.	Size.	Ft.
18-in.	1,826	9-in.	14,537
15-in.	16,223	6-in.	73,072
12-in.	13,458	4-in.	21,120
Total.			140,236

To Oct. 22, 1892, the extent of the vitrified pipe sanitary sewers, by sizes, was as follows:

Size.	Ft.	Size.	Ft.
18-in.	4,340	9-in.	7,210
15-in.	3,170	6-in.	32,250
12-in.	1,220	4-in.	31,350
Total			79,540

Manholes are placed from 140 to 165 ft. apart, and on the sanitary sewers have perforated covers, provision being made for the catching of the dirt which passes through the perforations.

The 9, 12, 15 and 18-in. sanitary sewers are flushed directly from the water mains. Additional flushing is secured, or was in 1882, from automatic flushing basins which receive all but the water closet wastes of several houses and discharge it by means of siphons. The basins also act as grease traps, the siphons being especially designed to remove grease and scum from the basins.

Sewage is received in a 300,000-gallon reservoir, 60 ft. in diameter and 15 ft. deep, located beneath the water-works tower. The outlet sewers at the reservoir are about 16 ft. below the general grade of Pullman.

The reservoir is ventilated by means of eight flues, each 165 ft. high, lined with 12-in. sewer pipe, built into the buttresses of the water tower, and also by a 20-in. pipe leading to the chimney of the car shops.

Both the sewage and water-works pumps are placed about 10 ft. below the ground surface on a masonry floor, supported by piers, covering the sewage reservoir. There are two 2,500,000-gallon pumping engines, built by the Cope & Maxwell Manufacturing Co., of Hamilton, O. The pumps have special valves, described in our issue of June 17, 1882. Connected with the force main at the pumps is a stand-pipe with an overflow 54 ft., and a second, 90 ft. above datum (not defined). These overflows connect with the reservoir, so if all the outlets at the farm were by accident closed without the pump being stopped no accident could occur. A 20-in. force main about three miles long leads to the sewage farm.

The amount of sewage pumped yearly from the reservoir to the sewage farm has been as follows:

Year.	Gallons.
1882	211,620,160
1883	358,354,420
1884	443,815,480
1885	468,302,120
1886	472,748,080
1887	573,700,640
1888	588,607,720
1889	602,250,000
1890	657,001,360
1891	617,664,000
1892 (9 months)	513,996,060

The amount given for the nine months of 1892 is at the annual rate of 685,328,090 gallons.

The cost of operating one pump for 20 hours and pumping 1,800,000 gallons of sewage is, given by Mr. Doty, as follows:

Cost of coal used	$1.73
Cost of oil and waste	.57
Engineer's wages	3.75
Total	$6.05

This is at the rate of $3.36 per million gallons.

Fig. 56 is a photographic view of the tower and Fig. 57 a vertical section through half of it. This unique structure, with its many uses, is 68 ft. square at the base, changes to octagonal form, as shown by the view Fig. 56, and is 195 ft. high to the base and 210 ft. to the top of the flagstaff. The foundation extends nearly 40 ft. below the ground surface, where it rests on a very hard blue clay.

The tower was built to afford elevation for the water tank at its top, which is of boiler iron, 55 ft. 10 ins. in diameter, 30 ft. 1 in. deep, and has a capacity of about 550,000 gallons. The tank is supported by iron trusses, resting on four wrought-iron columns, which extend to the foundations.

In December, 1890, the second floor of the tower

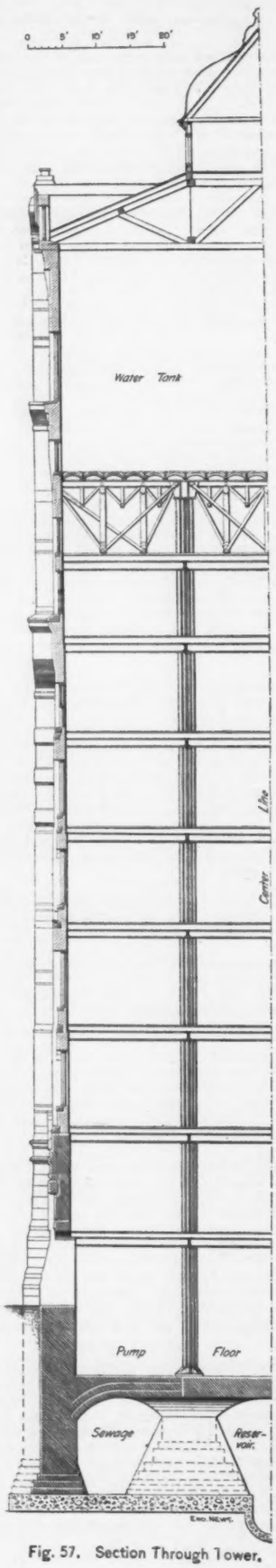


Fig. 57. Section Through Tower.

* Engineering News, June 17, 1882. The description was slightly condensed from a paper on "The Pullman Sewerage," by Benezette Williams, C. E., engineer for the system, read before the Western Society of Engineers, June 5, 1882, and published in the "Journal of the Association of Engineering Societies," vol. I., pp. 311-319.

was occupied by the electrical department of the Pullman car shop; the third and fourth floors were used for making mirrors and other glass work; the fifth floor was occupied by a branch of the paint department, and the floors above were used for light storage, elevators being provided to reach the different stories.

The building at the right of the tower contains the Corliss engine which furnished power for Machinery Hall at the Centennial Exposition at Philadelphia in 1876. This engine has been in operation at the Pullman Car Works since April 5, 1881.

The accompanying illustration, Fig. 58, shows the screening tank and automatic regulating valve at the farm end of the force main. The following description of these devices is from Mr. Williams' paper, mentioned above:

The farm end of this main connects with a closed screening tank, by means of which all material that will not pass through a screen of ½-in. mesh is intercepted. The tank is 6 ft. in diameter and 24 ft. long, made of ¼-in. boiler iron. It is set vertically, with its lower end high enough above the floor to admit of a wagon being driven under it. The material intercepted by the screen is lodged in the lower part of the tank, from which it is removed from time to time.

On leaving the tank the sewage passes through a pressure regulating valve, which limits the pressure that comes upon the pipes leading to the fields to about 10 lbs. As an additional precaution against high pressure, an overflow pipe is provided, which will absolutely,

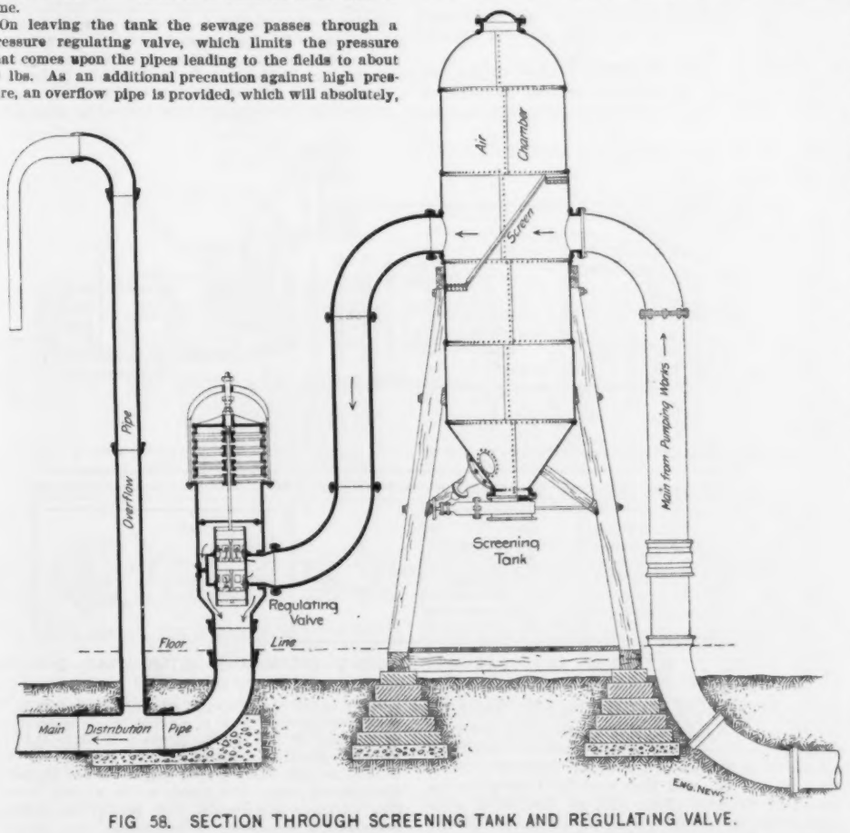


FIG 58. SECTION THROUGH SCREENING TANK AND REGULATING VALVE.

under all conditions, prevent the pressure from rising above the limit. This pipe comes into play occasionally when the pumps are started suddenly, without giving the valve time to act. The valve is purposely made to act slowly, in order to avoid the influence of pulsations in the engines, and irregularities from other causes.

The action of the tank and valve are better understood by an examination of the accompanying drawing (Fig. 58).

A pressure on the interior of the thin steel discs above the valve, raises the plunger and closes the port through which the sewage passes. If the pressure falls, the ports open gently. Vibrations of the valve from sudden changes of pressure are prevented by a plate between the valve and the steel disks, through small holes in which the sewage has to pass in order to increase or diminish the pressure on the discs.

The upper part of the tank above the screen is an air chamber, and answers the usual purpose of such an adjunct in preventing shocks from irregularities in the pumps, or by the sudden stopping of the flow of sewage. The tank and valves are housed in, and can be kept warm to prevent freezing in cold weather.

The reason for introducing the pressure regulating valve between the screening tank and the field, is to make it possible to distribute sewage safely through clay sewage pipes under pressure.

The sewage farm embraces 140 acres piped and underdrained for the reception and purification of sewage. All this land can be irrigated, and it is all underdrained. Vitrified pipe, from 6 ins. to 1 ft. in diameter, conducts the sewage through the fields. This piping, laid from 5 to 6 ft. deep, and hydrants at convenient intervals of 300 or 400 ft., distributes the sewage over the surface.

The underdrains in the farm are of 3 and 4-in. farm tile, laid in rows 50 ft. apart.

There are also 15 filter beds, about an acre each, formed by earth embankments, and underdrained with lines of farm tile said to be 2 ft. apart.

Mr. Doty states that the use of sewage for growing crops depends upon the season. In dry seasons it is freely used with the vegetation needing it most. Irrigation is practiced at all seasons, and the waters filter through the soil as well in the winter as during the summer. The crops which have so far proved most successful are onions, potatoes, cabbages, celery, beets, parsnips, carrots, sweet corn, and squashes. Potatoes are the least successful crop, celery, asparagus, and cauliflower coming next in order as not growing so well on this farm. Properly cultivated, twice as much can be raised on land irrigated with sewage as upon adjacent land unirrigated; and with onions the results are still better. It is stated that there never has been trouble with deposits of sludge upon the surface of the farm.

Mr. Doty states that the only analysis of Pullman sewage and effluent in his possession was made in the office of the Massachusetts State Board of Health, Nov. 30, 1887, with results as follows, analysis of water from the farm well being also given for comparison:

	Ammonia. Free.	Albuminoid.	Chlorine.	Nitrogen.
Pure sewage....	2.3000	.3200	1.98	None
Filtered sewage from manhole on filter bed....	.8500	.0480	2.31	1.500
Filtered sewage from mouth of main underdrain.....	.0026	.0108	3.78	.650
Water from farm well....	.0900	.0166	1.78	.033

The effluent from the farm passes through the underdrains into Lake Calumet.

Regarding what proportion of the sewage is used for broad irrigation and what proportion is passed through the filter beds, and as to whether the sewage is always purified before passing into Lake Calumet, Mr. Doty sends the following, under date of Nov. 28, 1892, which he gives as "the language of the superintendent of the farm:"

The sewage when not needed upon the fields of the farm is run onto the filter beds, and these filter beds are plowed up four or five times a year so as to loosen the soil and expose as much of it as possible to the air. At times, all the sewage is used upon the farm, and in wet weather not more than half of it. Some seasons have taken all the sewage upon the fields. At rare intervals only, when it has been necessary to clean the receiving tank at the farm end of the iron main, is raw sewage run into Calumet Lake, and then for very brief periods, and not enough of it to do any harm.

That this statement from the superintendent of the sewage farm is not in accord with observations made at Pullman by five different persons is shown by the statements given below. The remarks of Mr. Allen in the report mentioned and a conversation with Mr. Hazen, together with the fact that the Pullman plant has for many years been widely known and cited as a successful example of American sewage farming, led to a somewhat thorough investigation of the subject, the results of which are herewith presented and need no comment further than the remark that because profit is put before purification at Pullman, it does not follow that sewage purification by means of broad irrigation is in any degree a failure, it often being a useful method or adjunct of sewage disposal.

Mr. Geo. H. Benzenberg, M. Am. Soc. C. E., City Engineer of Milwaukee, Wis., wrote as follows on Nov. 21, 1892:

I have not been at Pullman for a number of years, and hence cannot give you any information whatever as to what they are doing there now, but I know that as early as previous to 1887, a large amount of crude sewage was run into Lake Calumet. This I found to be the fact upon a visit to the farm, and which finally the superintendent admitted and excused by saying that it was necessary in order to save the crops. The sewage was being run in a large open ditch, covered by bushes growing on each side, from near the farm to the lake. As to their success in disposing of sewage by intermittent filtration, I am not at all acquainted.

About a month after the date of Mr. Benzenberg's letter, Mr. Rudolph Hering, M. Am. Soc. C. E., of New York, corroborated the above by stating that he visited the farm in 1886 and also in 1887. He found that a large amount of crude sewage had been run into Lake Calumet just prior to his visit, as the large open ditch leading from the farm to the lake was still partially filled with crude sewage. The superintendent likewise admitted to him that it was necessary to do this occasionally to save the crops.

In his report on the "Sewage Disposal of Worcester" Mr. C. A. Allen, M. Am. Soc. C. E., City Engineer of Worcester, Mass., describes a visit to the Pullman sewage farm, made January, 1887, as follows:

The farm has an area of about 140 acres, nearly all of which is devoted to irrigation; there are 10 acres, however, set apart for a filtration area, this being thoroughly underdrained, the drains being about 2 ft. apart.

Upon the day of our visit it was quite warm, the thermometer registering 40° F. We found that the sewage was being discharged upon the filtration area, the first section of which was covered with sludge to a depth of about a foot. The sewage was running over this, to the second section, which was partially covered with ice, and then over the remaining area, which was entirely covered with ice, and was finally discharged into the effluent trench without having been filtered in the least.

The entire area was completely covered with sewage, and there was evidently no filtration taking place, as about the same quantity passed off at the lower end of the beds as was discharged upon the upper end.

The manager of the farm was away, but we were given the following facts by his assistant, which we subsequently verified:

The farm is run for the purpose of making money,

the purification of the sewage being a secondary consideration.

During the summer months when vegetation has received all the sewage it will bear, it is simply turned into Lake Calumet in its crude state.

We were told that not a particle of sewage has been applied to the farm proper this winter, it all having been simply passed over the area as already described.

What Mr. Benzenberg, Mr. Hering and Mr. Allen saw and learned in 1886 and 1887, and more, was still to be seen and learned in 1891, according to a letter recently received from Mr. Allen Hazen, Chemist in Charge of the Lawrence Experiment Station of the Massachusetts State Board of Health. Mr. Hazen states the condition of the filter beds, and gives a mechanical analysis of the surface soil of the filter beds. His letter is as follows:

I visited the Pullman sewage farm in October, 1891. The superintendent was absent, and I was shown about by a man who had worked on the farm for some years. He told me that with the application of sewage, worms developed in the soil and destroyed the crops, and for this reason no sewage had been applied for two or three years. Large quantities of horse manure from Chicago stables are applied to the land, but no sewage whatever. After broad irrigation was abandoned, so-called intermittent filtration was tried on ten acres of soil on which no crops were grown.

The filter was not in use at the time of my visit, nor did it have the appearance of having been used. My guide thought that it was at least a month since any sewage had been applied, and a much longer time since any considerable quantity had been treated. The sewage of the entire town was being turned directly into Lake Calumet, from which quantities of ice for Chicago are cut.

A sample of the surface soil of the filter had the following mechanical analysis:

Finer than	.24 mm		87%
" "	.12 "		42 "
" "	.06 "		28 "
" "	.03 "		16 "
" "	.01 "		08 "
		organic	08 "

Albuminoid ammonia, 225 parts in 100,000.

The analysis shows the material to be very much finer than the sands successfully used in Massachusetts, and it would hardly be possible to put upon it, with good results, any large volume of sewage.

On Nov. 21, 1892, a representative of this paper visited Pullman. Neither the superintendent or foreman of the farm were to be found. The building which covers the screening tank at the end of the iron force main is represented as having "a decidedly shiftless and unused appearance," the interior being used as a storage room for plows, cultivators, harrows, including the part originally designed for loading wagons when cleaning out the screening tank. Sewage was found to be flowing through the ditch leading to Lake Calumet. This ditch is about 4 ft. wide, 2½ ft. deep, and ¾ miles long. Located on Lake Calumet are two large ice houses belonging to Swift & Co.

The only person about, who said that he was a time-keeper, stated that the matter flowing in the ditch was the sewage as it came from Pullman and was all the sewage from the city.

A pair of triple-expansion condensing Corliss engines of 2,400 HP. each, has been erected at the new mill of the Fall River Iron Works Co. by the Corliss Steam Engine Co., of Providence, R. I. The cylinders are 23½, 36½ and 54 ins. diameter, 5-ft. stroke, and are arranged tandem. The pulley flywheel is 2 ft. diameter, and 15 ft. 4 ins. wide at the face, carrying four driving belts. The weight of the wheel is about 75 tons.

The Channel tunnel question is up again in England, and Mr. Gladstone, who favored the scheme when a member of the House of Commons, is expected as Prime Minister to wield much more influence in pushing the movement. The french are eager for the tunnel, and have driven 6,600 ft. of a large heading from their side. But this very eagerness of the Frenchmen furnishes the strongest argument for Englishmen of the Lord Wolseley type against destroying the insular strength of Great Britain.

The new Georgia road-law, which is now in effect, calls for a capable superintendent of highways, elected by the county commissioners of each county, and requires all men between 16 and 50 years of age to devote not more than 10 days' work annually on the roads, or to pay instead not more than 50 cts. per day. The most essential part of the new system is an ad valorem tax of not more than 0.2% for road purposes.

RECENT DEVELOPMENTS IN STEAM TURBINES.

In our issue of Feb. 27, 1892, we published an exhaustive review of the progress thus far made in the utilization of the expansive force of steam by turbines, describing and illustrating the turbines invented by Mr. J. H. Dow, of Cleveland, O., and by Hon. C. A. Parsons, of Newcastle, England.

The Parsons turbine has been proved so successful and economical that a central station to supply electrical current for the colleges and town of Cambridge, England, is now being equipped entirely with Parsons turbines and direct coupled dynamos. In our former description of the Parsons turbine we reported a test by Prof. J. A. Ewing, F. R. S., of Cambridge University, on a Parsons turbine, in which a steam consumption was obtained as low as 27.6 lbs. (at 95 lbs. pressure) per E. HP. per hour. Prior to the adoption of the steam turbines for the Cambridge station a second series of tests was made by Professor Ewing, and the effect was tried of superheating the steam used. In this manner steam consumptions were obtained but little over 20 lbs. per E. HP. per hour. As an efficiency of about 97% is claimed for the dynamos, this corresponds to about 19½ lbs. per HP.-hour of work actually done by the steam.

The plant at the Cambridge central station consists at present of three independent turbines, direct coupled to alternating dynamos, each machine having an output of 120 K-W. per hour (about 160 E. HP.). The station building contains room for three more machines of larger capacity, which will be added as soon as required, and the engine room, only 50×35 ft., will then contain a complete engine and dynamo plant with an output of some 1,200 HP. or more. Steam is furnished to the turbines from Lancashire boilers designed for a working pressure of 140 lbs. per sq. in. Jet condensers working down to an absolute pressure of about 1 lb. per sq. in. are attached to the turbines. The speed of the turbines and dynamos is 4,800 revolutions per minute. The alternating dynamo gives 60 amperes of current at 2,000 volts potential, with 80 alternations per second. A separate exciter for the fields is coupled to the same shaft. As there are no reciprocating parts, there is practically no vibration, and each machine rests on rubber blocks with no holding-down bolts. The dynamos have an electrical efficiency of 97.5%.

We condense as follows Professor Ewing's report on tests of the Parsons turbine made last August:

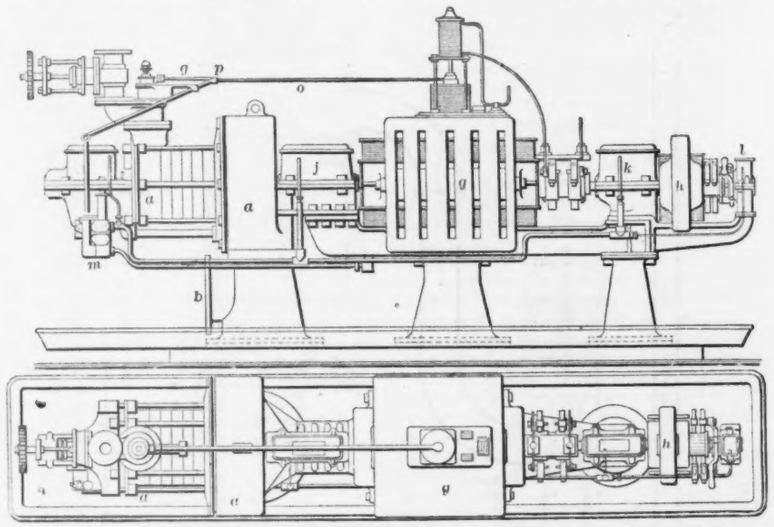
I have to report the results of a further series of trials on the Parsons steam turbine, with the object of testing how far the efficiency has been improved by certain recent changes, and by the use of superheated steam. The same turbine was used in these as in the former trials; but some additional rings of turbine blades were inserted at the high-pressure end to enable it to deal more effectively with pressures up to 115 lbs. per sq. in. (absolute); the vacuum was improved by the use of a larger air-pump and by admitting the injection water at a point of the exhaust pipe closer to the turbine, and there was a new governor.

The chief factor in the improvement which has now been brought about is, however, the use of moderately superheated steam. The improvement demonstrated by these new trials is very marked. Thus, in the present turbine, with steam superheated 60° F. above the temperature of saturation, the gross amount of feed water is 28.4 lbs. per K-W.-hour when the machine is working

Table I.—General Results of Test.

	Pressure by gage on boiler	Temperature of steam.	Load in K-W. per hour.	Feed water per hour, lbs.		
	Lbs per sq. in.	Deg. F.		Total.	Per K-W.	Per E. HP.
Continuous current moderate superheating.	96	335	0.1	480	....	....
	102	365	10.2	760	74.5	55.6
	100	356	27.0	1,110	41.1	30.7
	102	400	49 2	1,590	32.3	24.1
	100	390	74.5	2,170	29.1	21.7
	103	398	102.0	2,900	28.4	21.1
Continuous current, high superheating.	102	463	28.3	1,060	37.5	28.0
	102	468	49.5	1,480	29.9	22.3
	101	465	78.4	2,170	27.7	20.7
Alternating current, moderate superheating.	99	367	31.6	1,180	37.3	27.8
	97	394	49.9	1,550	31 1	23.2
	103	399	105.2	2,970	28.2	21.0

at full load, and 32 lbs. per K-W.-hour at half load. By carrying the superheating further (to 123° F. above saturation), the consumption at full load is reduced to 27 lbs. per K-W.-hour. Comparing these figures with those of the former trial, it will be seen that the consumption of steam has been reduced by about 27%.



FIGS. 1 AND 2. ELEVATION AND PLAN OF PARSON'S STEAM AND ALTERNATING DYNAMOS.

What makes these results specially important is the consideration that there is nothing in the construction or working of the turbine to make it likely that the use of superheated steam will be attended by any drawbacks such as have been experienced in engines of the ordinary type. The steam works without lubrication, it comes into contact with no rubbing surfaces, and there is no packing to be injured.

A general view of the plant tested is given in elevation in Fig. 1 and in plan in Fig. 2. The turbine case a a contains a series of seven revolving disks, from the surface of which the turbine blades project. They are arranged on each disk in a series of concentric rings. The fixed guide blades stand in spaces between these rings, being carried by annular disks which are fixed to the case. Thus each revolving disk, with its neighboring fixed disk, forms a series of outward-flow

Table II.—Consumption of Feed Water at Various Loads.

Current output in K-W. per hour.	Feed water consumption per hour, lbs. With superheating to about 400° Fahr.		With extra superheating to 465° Fahr.	
	Per K-W.	Per E. HP.	Per K-W.	Per E. HP.
20	48	35.8	....	....
30	39	29.1	36½	27.2
40	34½	25.7	32	23.9
50	32	23.9	29½	22.0
60	30½	22.7	28½	21.3
70	29½	22.0	28	20.9
80	29	21.6	27½	20.5
90	28½	21.3	(27)	(20.1)
100	28½	21.3	(27)	(20.1)

turbines, the steam entering the series inside the smallest ring of blades and escaping at the circumference into a channel, which conducts it between the back of the revolving disk and of the next fixed disk to the inside of the next series of rings. The arrangement will be understood by reference to Fig. 3, which is a section showing the first three turbine disks. The heights and apertures of the turbine blades on each disks are adapted to the increasing volume of the steam as it expands from an absolute pressure of 115 lbs. per sq. in., to an absolute pressure of 1 lb. per sq. in.

The first six disks, which are each 15 ins. in diameter, are designed to expand the steam to about atmospheric pressure, the remainder of the expansion being performed in passing the seventh disk, which is 26¾ ins. in diameter, and has (unlike the other six) a double series of rings of blades, one series on each side, through which the steam flows "in parallel." The height to which the turbine blades project above the disks in which they are secured varies from 3-16 in. to 1 in. The whole number of rings of moving blades in the machine tested was 35. The blades are made of strong sheet brass, and show no sign of wear after continued use.

Steam enters the turbine case at one end through a double-beat valve, shown in Fig. 3, and after passing the successive turbine disks is discharged at b (Fig. 1) to a condenser. The longitudinal pressure on the turbine shaft, due to the one-sided character of the six smaller turbine disks, is balanced at the high-pressure end by a revolving baffle piston (Fig. 3), with a number of deep grooves on its circumference, which are entered by corresponding projections on a fixed bush resembling a thrust block. Any small amount of longitudinal thrust which may remain unbalanced is received by an adjustable grooved thrust bearing at the end of the spindle, beyond the main bearing. This, which is contained in the oil box c (Fig. 3), is shown to a larger scale in section in Fig. 2.

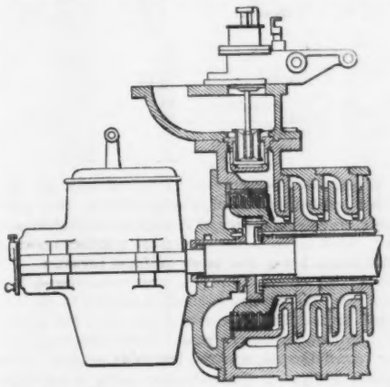


Fig. 3. Section Through Admission End of Steam Turbine.

The thrust bearing (Fig. 2) consists of seven collars on the spindle, revolving in a grooved bush, which is split longitudinally into halves with separate longitudinal adjustment to allow any wear to be taken up, so that end shake is prevented, and the endwise position of the shaft is maintained with great precision. This device also gives a means of regulating the amount of clearance over the tips of the turbine blades. The thrust bearing, like the main bearing, runs in a bath of oil.

The report then describes the ingenious main bearing used, consisting of concentric tubes, with a film of oil filling the spaces between them (See Fig. 4). A detailed description will be found in our issue of Feb. 27, 1892. This bearing permits the whole machine to revolve about its center of gravity, and prevents vibrations due to imperfect balancing. All these bearings, as well as the thrust bearing, are in closed chambers filled with oil which is circulated by a small force pump driven by an eccentric, which, in turn, is driven by a worm on the main shaft, shown in Fig. 2. Of course the power required to work the pump is very small, but the successful use of a worm gear rotating at nearly 5,000 revolutions per minute is something worthy of especial notice. The report continues with a description of the novel type of governor used.

The governing of the machine tested was accomplished by a novel and extremely effective appliance. Steam was admitted to the turbine in a series of gusts by the periodic opening and closing of the double-beat lift valve shown in Fig. 3. This valve was operated by means of a steam relay in mechanical connection with the turbine shaft so that the valve was opened regularly once in every 28 revolutions of the shaft. The duration of each gust was controlled by an electric solenoid, which was connected as a shunt to the field magnets, but was compounded so as to keep the voltage constant. The core of the solenoid was hung from the end of a long lever o, Fig. 1. The fulcrum p of this lever was periodically moved up and down by means of a link connecting it with the eccentric, which also served to drive the oil pump. The short end of the lever q controlled the valve of the steam relay. Each periodic movement caused a gust of steam to be admitted to the turbine, the duration of the gust depending on the height of the distant end of the lever.

The effect was that at full load the gusts became blended into an almost continuous blast, the lift valve closing only momentarily, or not at all, in each of the periodic movements; under any lighter load each interval of admission alternated with an interval during which the steam was completely shut off. The action of the governor was most satisfactory. The periods of admission were so frequent that they caused no material throbbing of speed, nor any variation of voltage sensible on a voltmeter. There was no hunting, and the freedom from friction was greater than I have seen in any governor. I repeatedly threw the whole load, amounting to over 130 E. HP., on and off suddenly, without causing more than a momentary variation in the voltage. The governor was sensitive, quick and certain in its action to quite an exceptional degree.

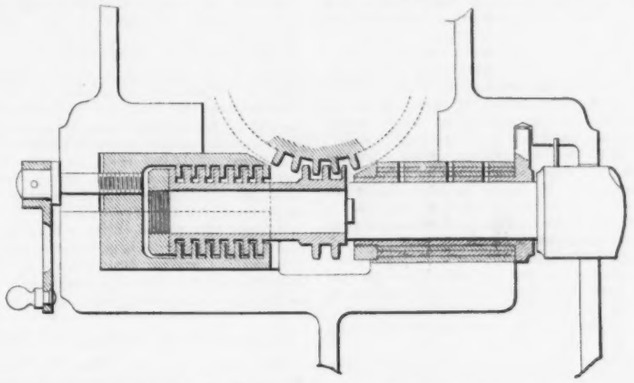


FIG. 4 SECTION THROUGH OIL CHAMBER, SHOWING MAIN AND THRUST BEARINGS AND WORM GEAR DRIVING OIL PUMP.

By applying an indicator at the admission end of the turbine chamber, below the double-beat valve, observation was made of the pressure during the periodic admission of steam; this was done by pulling the paper drum of the indicator as steadily round as possible by hand while the pencil rose and fell. Figs. 5 and 6 are examples of diagrams obtained in this way. The pressure which these diagrams show during admission is about 4 lbs. less than that shown at the same time by a pressure gage on the steam pipe above the governor valve.

Steam for the turbine was supplied at a pressure of 100 lbs. per sq. in. by gage from a locomotive boiler which was capable of giving enough for the full load of 100 K-W. per hour. The feed water was measured by putting it through a tank, the graduations and total capacity of which I checked by weighing water into it. The contents of this tank were delivered into a second tank, from which the feed pump drew its supply, and in which the level of the water was adjusted to have the same value at the beginning and end of each period of observation. The level of water in the boiler was kept as nearly as possible constant throughout.

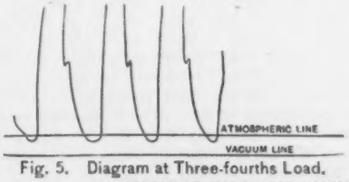


Fig. 5. Diagram at Three-fourths Load.

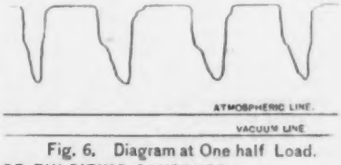


Fig. 6. Diagram at One half Load.

INDICATOR DIAGRAMS SHOWING ACTION OF PULSATING GOVERNOR.

In all the statements which follow of the results of these trials the quantity of feed water named is the gross quantity supplied to the boiler, no deduction having been made for leakage, blow-off at the safety valve, or other loss.

Three sets of tests were made. In the first the steam was superheated to about 400° F. (the temperature of saturation being about 338°). A continuous current armature was used on the motor. In a water resistance, formed by sticking two rods to serve as terminals some 10 yds. apart in a pond. The amount of resistance was adjusted by immersing the rods more or less deeply in the water. The current output measured was in each case the work done on these resistances, and the amount of current used by the separate exciter was not measured.

The methods of electrical measurement, as described by Professor Ewing, were most thorough and precise. The instruments used were tested before use, and the alternating circuit's voltage was measured directly and also after passing through a 1 to 20 step-down transformer.

In each trial the turbine was run long enough beforehand to establish a nearly uniform rate of working, and the trial was continued long enough to eliminate material error due to inexact readings of the water level in the boiler. The steam temperature was measured by a thermometer in a mercury pocket in the steam pipe, close to the turbine. A steam gage at this point showed a pressure 2 to 3 lbs. below that in the boiler. It will be noticed in the tables that in the trials with moderate superheating the steam temperatures were not much raised with the partial loads, the reason being that the boiler fire was not then being forced, and the fine superheater did not attain a high temperature. Table I. gives the results of the three tests. The vacuum in the condenser during the tests was 27¼ to 28½ ins., and the injection water was at a temperature of about 73° F.

Table II. shows the variation in economy with change of load, and Fig. 7 is a diagram on which the rates of feed water consumption with various loads are plotted. Professor Ewing comments as follows on these results:

The trials show that a very considerable advantage is realized by moderate superheating. To superheat the steam from, say, 338° F. (the temperature of saturation for a boiler pressure of 100 lbs.) to 400° F. requires the addition of barely 30 h. u., which is less than 3% of the heat taken up in the boiler. With steam superheated to this extent, the steam consumption at

In the second the superheating was carried to 465°, a direct current being generated as before. In the third the superheating was again 400°, and an alternating armature was placed on the dynamo. The direct current was used in the first tests in order that there might be no question as to the accuracy of measurement of the load. The trials with the alternating and with the direct current agreed very closely, proving that the methods of measurement of both currents were accurate. With the direct current tests the current generated was expended in heating resistance coils. The energy of the alternating current was absorbed by

full load is less by one-fourth than the consumption in the old trials. How much of this increase in economy is due to superheating alone cannot well be distinguished without further trials, as the comparison is complicated by the other improvements referred to at the beginning of this report. It is clear, however, that superheating is responsible for a great part of the difference.

Apart from the increased volume of the working substance, the advantage of superheating is to be ascribed in part to the prevention or reduction of the condensation at entry, which would otherwise take place in consequence of the intermittent character of the admission, and in part to its influence in keeping the steam dry during its expansion, and thereby reducing the internal resistances. At full load, when the steam enters in a nearly continuous blast, the latter effect is no doubt the more important.

The further advantage realized by superheating to 465° F. is comparatively small, especially at high loads. From evidence given by the temperature of the turbine case, it was clear that this amount of superheating not only kept the steam dry throughout its whole course through the turbine, but left it still considerably superheated at the end. This observation agrees with the result of calculation, which shows that an initial temperature of about 443° F. would be high enough to prevent the steam from becoming wet as it expands.

The general result of the trials is to demonstrate that the condensing steam turbine is an exceptionally economical heat engine. The application to it of moderately superheated steam has put the performance of the turbine on a level with that of the best steam engines of the ordinary type. A consumption of 27 lbs. or 28 lbs. of steam per K-W.-hour at full load, and 30 lbs. or 32

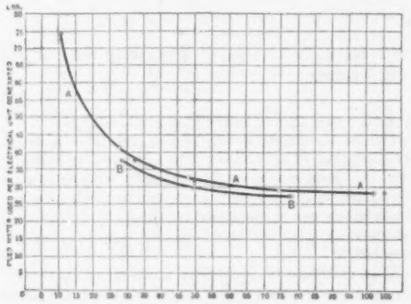


Fig. 7. Variation of Economy with Change of Load.

lbs. at half load, is a result that does not need to have its significance emphasized. The efficiency under comparatively small fractions of the full load is probably greater than in any steam engine, and is a feature of special interest in relation to the use of the turbine in electric lighting from central stations.

No allowance, as has been said, was made in these trials for leakage of steam and water from the boiler. It is well known that some leakage occurs under the most favorable conditions, and that if the quantity of steam used were measured after passing through the engine—as is often done in tests where a surface condenser is used—the results would be more favorable than those obtained by direct measurement of the feed. In the present instance it appeared (from separate observations) that the losses by leakage amounted to about 90 lbs. per hour, or, say, 3% of the whole consumption in the full-power trials. If this allowance were made, the quantities of steam per horsepower-hour and per unit would be reduced below the values stated above by about 3% in the full-power trials, and by about 6% in the half-power trials.

By applying the indicator at various parts of the turbine case, the range through which the pressure varies as each gust of steam passes, and the fall of pressure from one set of turbine rings to the next throughout the series, may be examined. This was done during the trials, with the result of showing that the apertures of the several turbines were not adjusted in the best possible relation to one another; in particular it was found that the turbine rings on the large disk at the condensing end gave too free a passage, and were doing less than their proper share of work. The readjustment of areas indicated by this test as desirable will, no doubt, secure even better results.

Apart from the other possible applications of a peculiarly light and efficient high-speed motor, the turbine dynamo in its present state is, in my opinion, eminently well fitted for central station use, not only on account of its economy of steam under both heavy and light loads, but also on account of its exceptional lightness and compactness, its small first cost, its independence of foundations, its freedom from vibration, its steady governing, its simplicity, the ease with which it is handled, and the moderate outlay which it may be expected to require under the heads of maintenance, oil and attendance. So far as I have been able to judge, the performance of the machine is as excellent as its details are ingenious.

We have commented on these tests in our editorial columns. We conclude this article with the following extract from a letter received some time ago from Mr. J. H. Dow, discussing the question of speed in steam turbines:

In regard to slow speed turbines, let me emphasize the statement that the linear velocity at each bucket series of the steam wheels of any steam turbine must approximate to half the velocity of the issuing steam jets, or economy of steam will be sacrificed more or less, according to the deficiency of speed. An increase in the number of compoundings, by reducing the diminution of pressure at each bucket series, will somewhat reduce the velocity of the jet, though not nearly in the ratio of the diminution of pressure. Increase in the diameter of the wheels, of course, permits a proportional reduction in the rotations per minute; but such increase of diameter adds to the weight of the turbine to a much greater degree than the increase of the power developed.

A speed of 16,000 revs. per min. is easily maintained by a turbine having steam wheels of 6½ ins. diameter. At this speed good efficiency is secured, and the output of 1 HP. for each 4 lbs. weight of turbine is entirely practicable. How to harness such enormous speed to every-day uses is the only problem which lies between the present development of the turbine and large usefulness. This problem is in a very fair way to be solved at an early day.

ADVANCE IN AMERICAN ORDNANCE.

The report of Com. Wm. M. Folger, Chief of Ordnance, to the Secretary of the Navy, for 1892, is interesting reading, in view of the fact that so late as March, 1885, we were buying armor-plate and gun steel abroad for our new warships and their armament.

According to this report we have made complete, in our own gun foundries and from American material, 237 guns of from 4 ins. to 13 ins. calibre, and have 77 more partly finished. Of the 381 guns required to arm the new ships authorized by law, 116 of the 237 guns made are actually afloat. The first 13-in. gun is almost completed and a second one is started; of the 12-in. guns 5 are made, and the finished list includes 25 10-in. 23 8-in., 135 6-in., 14 5-in., and 35 4-in. guns.

The Bureau, recognizing the serious disadvantages attending the use of hydraulic, electric or other power in handling heavy naval guns, proposes, as far as practicable, to use hand-power for this purpose. A simple and efficient mechanism has been developed for opening and closing the breech of 10 and 12-in. guns by hand, and the rapidity of fire is considerably increased thereby. An experimental nickel-steel 8-in. gun, from the design of Mr. William Sellers, of Philadelphia, is being made by the Bethlehem Iron Co. This gun has only three principal parts—a tube and an inner and outer jacket, and the expense of manufacture is thus much reduced. After considerable service, the eroded or damaged tube can be replaced by a new one. The physical properties of this forged nickel steel are from 10 to 15% higher than ordinary gun steel, and its successful test, of which there is little doubt, says the Chief of the Bureau, may lead to the use of this material for future gun construction.

The metallic cartridge cases now used with the 4-in., 5-in., and 6-in. calibers will probably soon be applied to guns of larger caliber, and the bureau is convinced that it is merely a question of time before this innovation will be a definitely recognized necessity in the military service of all nations. These metallic cartridges would do away with the "obturator," eliminate sponging, be advantageous in storing fixed ammunitions and increase the rapidity of fire. A new rapid-fire breech mechanism has been adapted in the later 6-in. guns; and even without the brass cartridge case proposed, there has been a marked increase in rapidity of fire; 10 rounds have been fired in 2 m. 57 sec., while with the ordinary service type of mechanism the same number of rounds required 5 m. 1 sec. With cartridge cases used in the 5-in. gun, a rapidity of fire of five shots in 19 secs. was attained, the gun, breech mechanism and cartridge working well. With the 4-in. gun, under similar conditions, five shots were fired in 14 secs., which means that at an elevation of 10°, corresponding to 6,000 yards range, five shells can be kept in the air together. Six 6-in. guns of 40 calibers in length and adapted for rapid firing with metallic cartridges cases, are now being made for certain of the fast cruising vessels.

Brown powder is easily obtained from Dupont & Co., of Wilmington, Del., suitable for guns up to 8-in. and 10-in. caliber, and filling the requirements of 2,000, 2,100, and 2,175 ft. sec., respectively, with 30, 35, and 40 calibers lengths of bore, and with a maximum pressure in no case to exceed 15 tons per sq. in. No entirely satisfactory 12-in. powder has yet been tested, unless a pressure of 17 tons per sq. in. be allowed. Under the new arrangements for storing ammunition, the powder is carried to the loading point in its storage case and the seal there first broken. All rapid-fire ammunition is protected by wooden cases until it is required for use in the gun. Since 1891 there has been a marked progress in the development of smokeless powder for the navy. The square, flat-grained type has been given up, and the macaroni form is used, with a diameter of stick ranging about 1-32 in., for small arms, to 2-10 in. for the 6-in. gun, the last being perforated, experiments show these powders to be stable and safe, after exposure for 20 hours to 212° F. of heat, or to 5° below zero. Tests made with this powder show the following results, the best so far attained:

	Charge, lbs.	Mux. velocity. ft.-sec.	Pressure, tons.
4-in rapid-fire gun.....	4.05	1,912	10.3
33-lb. shell.....	4.80	1,900	12.
M. N., 2 powder.....	5.20	2,125	14.7
	5.30	2,145	14.8
5-in. rapid-fire gun.....	11.	2,108	10.
50-lb. shell.....	12.	2,556	12.
M. N. 3, powder.....	13.12	2,474	14.2
	13.40	2,578	15.6
6-in. B. L. R., 40 calibers...	15.	1,535	5.1
100-lb. shell.....	19.	1,793	7.3
M. N. 6, powder.....	23.	2,151	11.2
	25.	2,369	12.6
	26.	2,469	13.9

When these results are compared with the published records of foreign experiments, they show the marked superiority of American smokeless powder which gives higher and more regular velocities with much lower and more uniform pressure. The same difficulties, however, are encountered here as abroad in adapting smokeless powder to use with small arms. The macaroni form, with the method of ignition necessary, would make machine loading impracticable, and the irregular packing of the square grains in the cartridge case, gives corresponding irregular results in velocity and pressure.

As to high explosives, 20,000 lbs. of gun cotton have been delivered by the Dupont Powder Co., and 27,551 lbs. were manufactured at the torpedo station at Newport, R. I., during the year. The experiments with emmensite were continued, and it has been demonstrated that an explosive of a high order can be obtained from this material by the use of a simple fuse, perfectly safe to fire, not containing fulminate and only requiring a percussion cap to ignite it. Shells filled with emmensite have been fired from a 6-in., wire-wound gun with a service velocity of 2,000 ft. sec. and exploded upon impact at 6,000 yds. range.

Armor-piercing shells for 6-in. and 8-in. calibers have been contracted for with the Carpenter Steel Co., of Reading, Pa., with a considerable increase in the severity of the acceptance test. This company has already furnished 1,025 6-in., 343 8-in., and 37 10-in., armor-piercing projectiles, and their acceptance test, side by side with the foreign shells of Firth and Holtzer, demonstrated, in the armor trials of the year, their excellent quality. In fact, the report of the Inspector of Ordnance says the Carpenter shells have shown definite features of superiority over the Firth and Holtzer shells tested with the same plates. The Sterling Steel Co., of Delmar, Del., has also succeeded in meeting the department's requirements for 6-in. armor-piercing projectiles. A cast-steel shot, cheaper and easier to manufacture than the forged-steel shells, though inferior in quality, has been developed by the department, and is being made by I. G. Johnson & Co., of Spuyten Duyvil, N. Y. The acceptance test requires these cast-steel projectiles to go through a steel plate one caliber thick with service velocity.

Commander W. M. Folger, Chief of Bureau, proposes a ram adapted to use the Ericsson 16-in. sub-marine gun. Experiments with this weapon

show that a fairly accurate range of at least 600 ft. can be obtained, and it is believed with a projectile heavier in the "after body" greater range and accuracy can be secured. This ram would be armed on deck with short-bore rifled mortars firing rolled nickel-steel shells charged with 200 lbs. of high explosive. The two submarine guns would discharge in rapid succession projectiles containing 500 lbs. of high explosives. The curved deck and side armor would be made of nickel-steel.

The successful tests of armor plate at Indian Head have already been fully detailed in this journal. It is sufficient to say that the Harvey process has demonstrated its great value, and the department has recommended that all armor plates used hereafter be so treated. High-grade nickel-steel, for wire for torpedo netting, is now made by the Bethlehem Iron Co., and its physical characteristics are shown in the following table:

Dimensions.

Size, ins.	Length, ins.	Tensile strength.	Elastic limit.	% Elongation.	% Contraction.	Treatment.
.500	2.0	114,590	56,020	47.25	68.44	Unannealed.
.500	2.	115,610	59,080	45.25	62.29	"
.495	2.	113 880	56,160	40.50	62.02	Annealed.
.490	2.	116,070	57,270	43.50	62.13	"

This alloy is practically non-corrodible in the atmosphere, and the bureau is of the opinion that this quality, coupled with its other physical characteristics, makes it especially adapted to the construction of guns subjected to high pressures with nitropowders. A fieldpiece and a few small-arm barrels are to be made to test this view. It is also recommended for the conning-towers of warships, as tests show that it is about one-tenth as susceptible to magnetic influences as ordinary steel.

Immigration in November was 27,482 this year against 38,615 in 1891, a much less difference than the restrictive measures still in force might be expected to cause. In the 11 months ending with November the decrease is only from 562,073 to 520,768.

STATISTICS OF STREET RAILWAYS OF THE UNITED STATES.

The accompanying table shows for each state the number of miles of street railways operated by horse, electric, cable, or steam power at the close of 1892, with the increase or decrease of mileage of each during the year. The second half of the table shows the corresponding figures for the number of cars operated by the various methods. These statistics were compiled by the "Street Railway Journal" from its directory; but have been rearranged by us for more convenient study and reference. The mileage of electric railways is seen to exceed that of all other street railways combined, although only a little over one-third the cars operated are credited to electric roads. This may be in part due to the reporting of cars used as trailers on electric and cable lines under the head of horse cars; but it is also largely due to the great number of horse cars still running in the cities of New York, Philadelphia and Chicago.

The enormous increase in electric railways in 1892, amounting to 1,878 miles of railway and 4,523 cars, is of course the most striking fact shown by the table. The construction of electric street roads is seen to be nearly half as great in mileage as the construction of extensions to steam railways. Considering the investment in central stations and electric plant and the comparatively cheap work done on many of the steam railway extensions, it is probable that the investment in electric railway extensions has not been far inferior to that in steam railway extensions during the past year. Horse railways are showing a great falling off, in both mileage and cars, and the few steam tramways or "dummy lines" are, on the whole, decreasing. Cable lines increased 52 miles and decreased 401 cars according to the table; but the figures concerning cars are to be taken with some caution, as there is room for much ambiguity in reporting trail cars, which may be operated on different systems in different parts of their run.

The total number of cars in use on street railway lines has reached the large figure of 38,400, which is nearly 15,000 in excess of the number of passenger cars in steam railway service. Comparing the two systems of transportation by the relation between cars and mileage, the street railways have 331 cars per 100 miles of line, while the steam railways have only 17.

The Vermont road-law, passed in 1892, requires a road commissioner to be elected by ballot in each district, who is to have all the duties and powers now conferred by law on road surveyors. He must give bonds equal to the amount to be expended by the dis-

Statistics of Street Railways of the United States at the Close of 1892.

	Mileage at the close of 1892.					Inc. or dec. in mileage during 1892					Cars operated at close of 1892.					Inc. or dec. in cars oper. during 1892				
New England.	Horse.	Elec.	Cable.	Steam.	Total.	Horse.	Elec.	Cable.	Steam	Total.	Horse.	Elec.	Cable.	Steam.	Total.	Horse.	Elec	Cable.	Steam.	Total.
Me	28	41	....	....	69	−17	+30	....	....	+13	75	87	....	....	162	−14	+50	...	....	+36
N. H	28	23	....	....	51	+2	+7	....	....	+9	70	25	....	....	95	+4	−7	....	....	−3
Vt	13	...	....	....	13	+2	....	....	....	+2	20	....	....	....	20	−2	....	....	....	−2
Mass	267	524	....	15	797	−215	+267	....	−1	+52	1,729	2,037	....	10	3,776	−1,536	+1,125	....	+2	−409
R. I	67	51	3	....	121	−2	+38	0	....	+36	410	65	14	....	489	+55	+34	−43	....	+46
Con	103	49	....	....	152	−14	+42	....	....	+28	370	111	....	....	481	−18	+95	....	....	+77
Total	506	688	3	15	1,183	−244	+384	0	−1	+139	2,674	2,325	14	10	5,023	−1,511	+1,297	−43	+2	−255
Middle.																				
N. Y	848	455	13	28	1,344	−73	+129	0	+20	+76	5,895	1,272	73	37	7,277	+18	+741	−15	+20	+764
N. J.	119	88	3	8	218	−91	+17	0	0	−74	436	295	7	20	758	−254	+54	−10	0	−210
Pa	688	484	70	....	1,242	+112	+146	+6	−4	+260	1,931	923	334	....	3,188	−14	+147	−5	−8	+120
Del	6	13	....	....	19	+1	+6	....	....	+7	22	50	....	....	72	−11	+27	....	....	+16
Md	133	67	10	2	212	−36	+58	0	+2	+24	439	94	35	4	572	−41	+85	+5	+4	+53
Dist. Col	54	45	22	....	121	−8	+16	+16	....	+24	267	87	389	....	743	−109	+25	+364	....	+289
Total	1,848	1,152	118	38	3,156	−95	+372	+22	+18	+317	8,990	2,691	838	61	12,580	−402	+1,079	+339	+16	+1,032
No. Central.																				
Ohio	204	538	44	4	790	−80	+160	00	+2	+82	436	1,566	197	4	2,203	−200	+506	−108	0	+198
Mich	68	209	....	15	292	−55	+52	...	+4	+1	380	513	..	11	904	−144	+275	....	+5	+136
Ind	91	157	....	8	256	−17	+50	...	+1	+34	172	371	....	14	557	−221	+207	....	+3	−11
Ill	365	316	85	10	776	−17	+87	+16	+2	+88	3,193	584	568	10	4,355	+1,182	+148	−774	−6	+550
Wis	66	120	....	....	186	−51	+71	..	....	+20	115	286	....	....	401	−195	+197	....	....	+2
Total	794	1 340	129	37	2,300	−220	+420	+16	+9	+225	4,296	3,120	765	39	8,420	+322	+1,333	−882	+2	+875
So. Atlantic.																				
Va	30	97	....	16	143	−12	+24	....	+12	+24	84	138	....	14	236	−17	+41	....	+14	+38
W. Va	21	33	....	10	64	+5	+17	....	+2	+24	30	51	....	20	101	+4	+12	....	+8	+24
N. C	5	33	....	4	42	−6	+6	..	+4	+4	7	56	....	5	68	−18	+14	....	+5	+1
S. C	38	....	....	....	38	+3	....	....	....	+3	99	....	....	....	99	+10	....	....	....	+10
Ga	59	160	....	16	235	−27	+61	....	−18	+16	103	236	....	11	350	−48	+85	....	−30	+7
Fla	28	18	....	10	56	−31	+18	....	+10	−3	53	10	....	5	68	−54	+10	....	+5	−39
Total	181	341	....	56	578	−68	+126	....	+10	+68	476	491	....	55	922	−123	+162	....	+2	+41
So. Central.																				
Ky	133	84	....	....	217	0	+12	....	....	+12	333	252	....	....	585	−11	+14	....	....	+3
Tenn	26	197	....	71	294	−8	+36	...	−3	+25	56	309	....	99	464	−65	+116	....	0	+51
Ala	60	40	....	150	250	−7	+32	....	−15	+10	157	65	....	119	341	+4	+57	....	−22	+39
Miss	21	....	....	6	27	+3	....	....	0	+3	54	..	....	10	64	+30	....	....	−3	+27
La	119	5	...	33	157	+2	0	....	−3	−1	442	8	...	36	486	−22	+4	....	0	−18
Total	359	326	....	260	945	−10	+80	....	−21	+49	1,042	634	....	364	1,940	−61	+191	...	−25	+102
Southwestern.																				
Mo	70	321	108	12	511	−22	+63	−10	−32	+5	458	1,040	1,079	20	2,597	−226	+133	+83	−59	−69
Ark	42	27	...	5	74	−18	+19	....	−2	−1	99	78	....	2	170	−98	+39	....	−1	−60
Tex	150	249	10	32	441	−39	+52	+4	0	+17	263	317	25	31	636	−201	+20	+1	−10	−190
Kan	59	68	2	31	163	−13	+2	+2	+14	+5	119	91	4	63	277	−10	−25	+4	+44	+13
Colo	20	152	43	....	215	−56	+22	+4	....	−30	30	273	300	....	603	−212	+9	+102	....	−101
Total	341	817	163	83	1,404	−148	+164	0	−20	−4	999	1,799	1,408	116	4,283	−747	+176	+190	−26	−407
Northwestern.																				
Ia	54	193	7	14	268	−4	+35	+3	−6	+28	113	421	34	17	585	−20	+163	+9	−14	+78
Minn	10	314	11	....	335	−6	+84	−5	....	+73	16	710	29	....	755	−10	−30	−44	....	−84
Neb	59	150	10	....	219	−8	+17	0	....	+9	183	238	22	....	443	−8	+15	0	....	+7
S. Dak	17	9	....	6	32	0	0	..	0	0	16	7	....	2	25	6	0	....	0	0
Wyo	5	....	....	....	5	0	....	....	....	0	11	....	....	....	11	0	....	....	....	0
Mont	....	60	6	5	71	−5	+17	0	−6	+6	....	67	4	5	76	−14	+23	0	−5	+4
Total	145	728	34	25	930	−23	+153	−2	−12	+116	339	1,443	89	24	1,895	−52	+111	−35	−19	+5
Pacific.																				
Wash	7	195	29	19	250	+1	+35	−2	−10	+24	8	226	75	7	316	−4	+72	0	−11	+57
Idaho	....	3	..	....	3	....	+3	....	....	+3	....	2	....	....	2	....	+2	....	....	+2
Ore	19	62	13	35	129	−15	+28	+7	+4	+24	39	108	45	43	235	+28	+22	+23	+8	+91
Cal	234	205	157	45	641	−18	+108	+11	−12	+89	587	264	737	69	1,657	−27	+63	+6	−66	−24
Ariz	6	....	....	....	6	+2	....	.	...	+2	4	....	....	..	4	−2	....	....	....	−2
Total	286	465	199	99	1,049	−30	+174	+16	−18	+142	638	600	857	119	2,214	−5	+179	+29	−69	+124
Total U. S	4,460	5,939	646	620	11,665	−842	+1,878	+52	−22	+1,066	19,315	13,415	3,971	698	37,399	−2,483	+4,523	−401	−117	+1,522

The total estimated cost of the Trans-Siberian railway from Chelabinsk to Vladivostok, 4,702 miles, is $195,600,000, or $41,600 per mile. This estimate includes the cost of sufficient equipment for light traffic. Work on the section from Vladivostok to Grafskara, 256 miles, which was begun in the spring of 1891, has made but little progress considering the force (about 6,000 men) employed. Grading has been completed or begun on about 160 miles, and eight miles of track have been laid. It is not expected that tracklaying will be completed from Vladivostok to Nikolsk, the first important station, 66 miles, before the fall of 1893. The construction of the entire line will take about twelve years if carried out according to the official program.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

XXXVII.

(With inset.)

(These articles will be republished in book form, and any corrections in the accompanying diagrams, if sent in before Jan. 23, will be incorporated in them before they are reproduced for the book.)

The 41 different diagrams herewith show graphically, for as many different colleges, the apportionment of time to six main classes of studies, as given in tabular form in our Table XXXIV., published Dec. 1, 1892. In response to our request, 13 different colleges have sent in corrections to that table, as also to the larger Table XXXIII., on which it is based. The corrections to Table XXXIV. were so numerous, and in one or two instances so considerable, that we shall reproduce it in corrected form in our next issue.

The diagrams show one course only for each college. When it had a civil engineering course that course was chosen. In two cases, however, a mechanical engineering course is given, and in three cases a mining course, as stated on the diagrams.

In preparing the following diagrams we have taken as the unit a year of 40 weeks. We perceive no reason why colleges which cut down the "year," as many of them do (see "Length of Course," Sept. 1, 1892), to 32 to 36 weeks should be credited with having the same kind of "year" as the 40-week colleges have; and we have purposely constructed these diagrams in such manner as to bring out clearly to what extent the several colleges fall short of giving these four full years of instruction, for we are frank to say that we regard it, in the proportions which it is assuming, as a great abuse, a leading cause for which, we cannot doubt, is a universal fondness among the professors for a good long summer vacation.

Not that many of these gentlemen consciously permit such a consideration to influence them. We neither charge this nor believe it. Nor do they, in most cases, have any power to act directly on the subject, but they have great influence in regard to it, and we cannot but believe that if there were some law of nature by which the professors' vacation varied inversely as the students', instead of directly therewith, there would be speedy perception at many colleges that the young men were wasting too large a portion of each year for their own good.

The extent of the evil and abuse (if it be such) may be seen by a glance at the diagrams. Out of the whole 41 there are only six which have the 40-week year, but by a significant coincidence these are among the very best and most earnest and most successful and most popular of all our engineering schools. No one will question that they crowd each week as full of work as any others in the list; and if their students can stand the pressure for 40 weeks of each year, "why in natur'" can't the rest? The answer is that they could and would be glad to, most of them, but they are not permitted to by the faculty. Thus the student, who enters at Columbia in the expectation that he is to pass four years of study there, does, as a matter of fact, but little over three years of good earnest work there, because, in addition to the 12-week vacation which a 40-week year permits, and which is long enough in all conscience for any reasonable human being in good health, nearly another entire year out of the four (32 out of 40 weeks) is frittered away in unconscionably long vacations, to the mental injury both of professors and students.

We are surprised and disappointed to see also that another school which is otherwise of the very first rank, the Massachusetts Institute of Technology (No. 11), is one of the greatest of offenders in this respect. It cuts down its "year" to only 34 weeks in its "civil" course (that shown on the diagram) and to only 33 weeks in its mechanical course, thus giving to its professors and students the unconscionably long vacations of 18 to 19 weeks, which, in the great majority of instances, is worse than wasted time for both the professors and students. As a consequence, its nominal "four-year" course (134 weeks as a mean of the civil and mechanical courses) means only one more week of study than the 3½-year course of the Worcester Polytechnic Institute (No. 21; 133 weeks), another school of sterling merit, and actually one week less of study than the THREE-YEAR course of the Michigan Mining School (No. 49; 135 weeks), whose course of 45 weeks yet leaves seven weeks of each year for vacation, which all professional men not professors would think a gorgeously long vacation, though most of them work their brains, perhaps, quite as hard as the professors, and nearly as hard as the college students, in proportion to their strength.

It follows that out of every four years the Massachusetts Institute of Technology is throwing away an entire year of possible work in extra vacations, in addition to the seven weeks per year which the professors and students of the Michigan Mining School find to be sufficient to recuperate their energies; and two-thirds (0.65) of a year in addition to the 12 weeks which six of our strongest colleges find adequate for their necessities.

A mere glance at the diagrams will show that, though there are few quite such pronounced instances of long vacations as the M. I. T., there are one or two still more pronounced, and that all but a select few tend strongly in the same direction.

What is to be said in favor of this practice? Let us rehearse all the grounds we know, to show that they are not forgotten nor ignored. It may be claimed that the long vacations are needed either by the professors or students or both. It may be claimed as to the students that they need them:

A. To work on the farm or at some other manual work. They used to at one time, but they do not to any extent any more, and are likely to do less and less of it in future.

B. To get field or shop practice in engineering. This, if the real end, would be much better secured by giving a full six months in the middle of the course; and still better yet by compressing the studious work into three years and giving them a whole extra year for practice either at the end of the course or, better yet, in the middle of it. But neither of these plans would lengthen out the professors' vacations.

C. To permit summer vacation class work. But this rarely occupies more than a few weeks in the whole course, and so far as any needed rest from study is concerned, is as much rest as lolling about at the seashore or mountains, so that there is no need to lengthen the vacations for it. We have to count in four weeks of such vacation work in order to make the M. I. T. "civil" course 34 weeks long.

D. For rest pure and simple, a claim too silly to discuss in respect to healthy young fellows of 18 or 20, although it may be sound enough as to young growing children.

There being no apparent ground for these long vacations for the students' sake, it must be for the professors'. It may be claimed that they need absolute rest for 18 or 19 weeks after each 33 or 34 weeks of work:

A. To engage in professional practice, so as to keep abreast of the times. But comparatively few of them do it or can get it, and they all have what all other professional men would consider luxurious hours in their weeks of work, in addition to their prolonged weeks of leisure, so that they have time for all the work most of them can get without prolonged vacations.

B. For "research." This may, and does, amply excuse giving to leading and exceptional professors not only 18 or 20 but 52 weeks per year of relief from routine class work. We would be the last to object to proper intervals of leisure for the real students and investigators to which mankind has been, and will be, in all ages so greatly indebted. But only a very small percentage of professors, as of all other classes, are fruitfully engaged in such researches. Granting that all who are should have full leisure, it is a claim too absurd for discussion that all the students and most of the professors, who are engaged in no such researches, must throw away a large fraction of every year in order to give leisure to the handful who are; especially as ample leisure, while a blessing to those who really are engaged in fruitful research, is worse than useless to coax men into it.

There remains, therefore, only this apparent reason for the 19-week vacations to professors:

C. Rest, pure and simple; a need which need hardly be discussed in view of the fact that a professor's hours of actual class-room work are rarely so much as four hours per day for five days in the week or $4 \times 5 \times 33 = 660$ hours in a year. Allowing whatever seems proper for the preparatory work necessary to keep the instruction given up to date, it is for the most part merely going over and over old familiar ground, and there would seem to be ample time left both for rest and for research, even if the above 660 hours were increased by seven weeks more of equally onerous work, or by 140 more hours in all, to 40 weeks and 800 hours of class work.

If there is another side to this question which we do not appreciate, we shall be glad to hear and to present it, but it appears to us that the showing of this diagram at least establishes a prima facie case, and calls for some affirmative evidence that the great differences in "years" are justifiable. Prima facie, it is absurd to take costly buildings and a costly staff, training young men who mean business and to whom every year is precious, and deliberately throw away the usufruct of all this plant for one year in four in order to extend vacations which other brainworkers would (if they ever got them) regard as luxuriously long at their shortest. Is it by mere coincidence or is it cause and effect, or is it for good reasons which we do not comprehend, that the only class of brain-workers who live upon dead men's money not their own are the only class which indulges itself in these inordinate vacations? We pause for a reply. Pending further light, we regard it as a case of gradual drift into an abuse of trust.

We have left ourselves no space in this issue for some notes in regard to the details of the individual diagrams. We will close, therefore, by merely defining more specifically what these details are.

The diagram gives the weeks of the entire course, or the years and tenths of a 40-week year, devoted to each of six main classes of studies, which are respectively, starting from the bottom of each diagram:

1. Elementary mathematics.
2. Advanced mathematics and physics, including electricity.
3. Collateral adjuncts (languages, literature and minor sciences).
4. Chemistry.
5. Surveying and astronomy.
6. Advanced technical.

In a general way these subjects come in the course in the order stated, more nearly than in any other order, but it must be clearly understood that the diagrams by no means represent the total time in the course during which each of these several subjects are studied, but only the total time in weeks or decimals of a 40-week year which each of these classes would occupy if the student's work during that time was wholly devoted to that particular class of studies.

The studies included under these several classes, as shown in Table XXXIII. (Dec. 1, 1892), are as follows:

A. Elementary mathematics includes algebra, geometry, trigonometry, analytical and descriptive geometry. Most of the time is devoted to the three latter studies at most of the colleges. Few of the better class of colleges devote more than two weeks in all to algebra and geometry together.

B. Advanced mathematics includes calculus and least squares, mechanics, graphical statics, physics and electro-physics. By far the greater portion of this time is, at all the colleges, devoted to mechanics and physics, as a reference to Table XXXIII. will show.

C. Collateral adjuncts. Under this head were included all studies not directly utilitarian in their nature but important in engineering practice, chiefly for the "general culture" derived from them. These include (1) modern languages, (2) English literature, political economy, constitutional history and all other "English" studies of that kind, (3) botany, (4) geology, (5) mineralogy, (6) zoology and (7) physiology. As a rule, the first two of these represent two-thirds to three-fourths of the total.

D. (Described as "minor technical" in Table XXXIII.) is subdivided in the diagrams into "chemistry" and "surveying, etc.," the "etc." meaning chiefly astronomy.

E. Advanced technical, under which head was included everything else in the course, including shop work and drawing. This class includes nearly all the work done in the senior year and a good part of that done in the junior year as well, as will be seen from the diagrams.

We have not thought it judicious to attempt to

make the diagrams so detailed as to show the time given to each single study as well as to each class. The effect would only be to obscure them. Those desiring to do so can subdivide any class by the information given in Table XXXIII., first taking pains to convert the "hours" given in that table into weeks.

Note: The undergraduate course of Washington University has recently been abbreviated from five years to four, as more fully explained in the letter which appears below.

WASHINGTON UNIVERSITY—LENGTH OF COURSE.

Sir: I desire to inform you of a recent action of the faculty of Washington University in returning to their former practice of granting a B. S. degree at the end of the fourth year of the straight five-year course in its Polytechnic School. After mature consideration for a year, and after a full discussion of the whole question, with all the information available in regard to the current practice at home and abroad, together with a consideration of the question on its merits, it has been decided by a large majority, though not unanimously, to grant B. S. degrees at the end of the fourth year. Although we still retain the fifth year as a constituent part of a full course in civil, mechanical, electrical, and mining engineering, it is to be expected that many of our students will leave us with their bachelor of science degrees, and not return.

This is our sixth year since the granting of these degrees was abolished, and it is probable that our experience may be considered of value to other engineering schools. Without going into details I may say that it was considered that a four-year student had earned this degree in the Polytechnic School as fully as he had on the "college" side of the institution, and was, therefore, equally entitled to it; also, that a necessary attendance of five years, with the standard requirements for admission, being 25% more time than was required at any other engineering school in the world, before any diploma was given, was an artificial standard which we could not afford to maintain alone. Furthermore, it became a serious question whether or not it was always wise to demand that the fifth year should be spent under the same instructors from whom alone the student had received professional guidance, rather than to allow the young man to go into his practical apprenticeship which must always supplement a school training.

In the consideration of this, the really important question, I may say that your article on this subject in the issue of Sept. 8, 1892, was read with considerable effect. After a discussion of the two horns of the dilemma in which the high-grade engineering schools have found themselves in recent years, namely, a greater length of course, or a narrow specialization of work, you very wisely say:

"Engineering practice, prices of material and of labor and the like, change so rapidly that it seems useless to teach such matters to students. However important they may be to an engineer in practice, the student has no use for them, and when he does come to need them, both prices and practice have changed so much that his college notes are worse than useless. Furthermore these matters are learned of necessity in actual practice, whereas new principles are then learned only by going out of one's way, returning to the text-books, and brushing up one's early acquirements in a way that is usually so distasteful to a busy practical man as to be prohibitive. But worse than this, an ignorance of principles is such an ignorance as includes itself. That is, a man ignorant of a principle is not usually aware of his ignorance, or what is the same thing, he is unaware of the existence of the principle. This is the most dangerous kind of ignorance. So long as a man knows the limitations of his own knowledge, he is a safe man, provided he is honest. But an honest ignorant man, who knows not his shortcomings, is a dangerous man to trust in engineering construction. The engineering school is called upon, therefore, to teach all such principles as serve as a basis for engineering practice, but it is not required to teach practice any farther than necessary to give zest and reality to the work and an intelligent understanding of the uses to be made of such principles.

"In all engineering schools, a careful revision of the work from time to time, which naturally grows in all its parts, like a plant or tree, with a liberal pruning out of some of those descriptive methods and practical details, being careful always to hold fast to a thorough mastery of (and not mere bowing acquaintance with) the great underlying principles, would probably enable them to obtain the requisite breadth of course without increasing the time beyond four years. This would seem preferable to either narrowing the work of each student to a specialty, or to increasing the length of the course to five years."

This is the whole problem in a nutshell. I believe quite enough of the principles on which engineering practice is and always will be founded can be taught in a four-years' course, with the standard requirements for entrance now prescribed by all our leading schools. For such students as can afford an additional year, or for such as are scientifically inclined, or who wish to further broaden their theoretical preparation, or who may anticipate teaching these subjects, a fifth year of college work should be offered, with ample laboratory facilities for original research, but I am thoroughly convinced that it is not wise, at least in the present state of society and of science, to insist on all students taking such additional year before any kind of graduation.

J. B. JOHNSON,
St. Louis, Mo., Jan. 7, 1893. Prof. Civ. Eng.

(We fully agree with the view expressed by our correspondent in this letter, and also still more pithily in an accompanying personal note, as follows:

"We are again in the ranks rather than in the clouds! We must not overdo this business of engineering schooling rather than education. The latter goes on forever, but the former should stop in time, before the engineer is spoiled in the making of a mere student. Our fifth year's course still stands for those (some 25% perhaps) who desire to take it."—Ed.)

PAPAGHNI BRIDGE; MADRAS RY., INDIA.

The Madras Ry., India, has completed the new Papaghni bridge, and it was inspected and passed by the government engineers last July. It consists of 15 spans of 136 ft., c. to c., of bearings, with a clear waterway of 131 ft. The girders are of the Whipple-Murphy type, and are of wrought iron with riveted connections, having a double system of lattice bars by which the adjacent panels are connected. The girders are 139 ft. 8 ins. long, 16 ft. effective depth, and spaced 18 ft. apart, c. to c. The weight of girders of each span is 328,384 lbs., exclusive of the rails and timbers, the weight of which is 28,728 lbs., the total weight of span being 357,112 lbs. The rails are carried on longitudinal timbers fixed in trough rail bearers, the latter being continuous over two spans and supported on cross girders at 8 ft. apart, c. to c. In consequence of the camber being taken up by the longitudinal timbers, the overhead clearance varies about 3 ins., the minimum headway being 14 ft. 6 ins. The wind bracing consists of eight horizontal overhead girders to each span. The average height of bottom of girders above the river bed is 17 ft.

The tests were made with two engines with tenders fully loaded, weighing 149,952 lbs. each, and two freight cars loaded with rails, weighing 49,938 lbs. The deflection was from 0.47 to 0.6 in., and the maximum permanent set was 0.07 in. The following is a summary of the loading:

	Lbs.
Dead load:	
Girders	328,384
Rails and timbers	28,728
Total dead load	357,112
Dead load per foot	2 912
Live load:	
Two engines	299,904
Two cars	99,876
Total live load	399,780
Live load per foot	2,632
Total load:	
Dead and live load	752,892
Total load per foot	5,544

The following particulars are abstracted from an article in "Indian Engineering":

The abutments have splayed wing walls and are built of sound flat bedded limestone. The masonry of the south abutment is built on seven masonry wells 12 ft. in diameter, 20 ft. in height above the curb, where the external diameter of the well is reduced to 11 ft. The wells are built of limestone in mortar, and there are three under each abutment and two under each wing. All are down to rock at a depth of about 57 ft. below the river bed except the wells under the two newels. That under the east newel is 40 ft. deep in clay, with one side of the curb resting on the masonry of the adjacent well; while that under the west newel rests on the curb of the next well, but is excavated to the rock, and filled up underneath with concrete. The seven wells of the north abutment are all founded on rock about 59 ft. below river bed, and all have gone down straight. The whole of the wells are filled throughout with Portland cement concrete. The tops of the wells are connected by arches on which the masonry abutments are carried.

The piers are 140 ft. apart, c. to c., and each formed of a pair of cast iron cylinders, 12 ft. diameter, placed 18 ft. apart, c. to c., transverse. These extend from the bottom rock 55 to 62 ft. below bed, to about 15 ft. below the river bed, while their diameter is reduced to 9 ft. by a conical taper piece 7 ft. 6 ins. high. From the top of this the cylinders are 9 ft. in diameter for the full height, being finished by an adjustable sliding cap and connected by massive wrought iron bracing boxes firmly bolted and filled with concrete.

Bracket segments have been introduced 12 ft. above the cutting edge of the cylinder piers forming a shelf inside the cylinders on which masonry lining of limestone in cement mortar, 2 ft. 9 ins. thick, was built as the pier was sunk, the object being to reduce the weight of rails necessary to sink the cylinder. The lining is carried up to half the height of the taper segment. The space from the rock to the under side of the bracket segment and the core within the masonry lining is filled with cement concrete; above this the cylinders are filled with solid masonry to within 3 ft. of the girder bearings, that below river bed being in cement mortar, and above this in surki mortar. The 3 ft. immediately below the bearings is filled with a mixture of sand and Portland cement in proportion of 2 to 1.

Some of the girders were built in the bed of the river, and after riveting complete were lifted by hydraulic jacks placed under the end posts, while others were erected above the tops of the piers on light stagings of old rails braced together and placed under each shipment joint of the bottom chords. The latter system of erection proved to be much cheaper than the former owing to the low height of piers.

The bridge has cost approximately $306,402, or at the rate of $146 per lin. ft., of which $196,410 was the original cost of ironwork, delivered in Madras. The total depth of the cylinders and wells is 2,364 ft., costing $14,170 and $11,630 respectively, including charges on account of bedding the cylinders and wells on the rock by divers. The hard material met with was 41.8%. The English cost of ironwork in piers and abutments was $85,142, and for girders $110,000, equal to a cost per ft. run of bridge (2,100 ft.) of $40 and $52, respectively.

THE PRESENT STATUS OF THE UNITED STATES TIMBER TESTS.

The examination and tests of timber now in progress under the Forestry Division of the Agricultural Department, Washington, were suspended from January to July of this year from want of funds. Mr. B. E. Fernow, Chief of the Forestry Division, asked Congress, in a special bill, for an appropriation of $40,000 for this work. This was wholly disallowed in the House, but the Senate added an amendment to the Department Bill, giving $12,000 to this investigation. This was finally cut down in conference to $4,000, which, with some additional funds from the general department appropriation, constitutes the working means for the current year. The work of testing was renewed in July, at the Washington University Testing Laboratory, St. Louis, under Prof. J. B. Johnson, and the collectors are again in the field.

Tests of strength have now been made on specimens from 32 trees of long leaf pine, four trees of short leaf pine and eight trees of loblolly pine; all from Alabama. Also on 20 trees of white pine from Wisconsin and on 34 trees of different species of oak from Alabama. Collections are now being made in Missouri, Arkansas, Texas and Louisiana of short leaf and long leaf pine.

Results have been compiled for a bulletin on the strength of long leaf pine, commonly known in the Eastern States as Georgia pine. Eleven of the 32 trees of this species tested had been bled, or boxed; that is they had been tapped for turpentine. This timber is usually excluded entirely from use in standard specifications, but the mills regularly saw and ship it, and claim no inspector can identify it. It is thought this bulletin will settle the question of the value of this bled timber, so far as its strength is concerned.

Mr. Wm. Kent, M. E., of New York, has been consulted as to the best plan to adopt in the analysis and publication of the vast mass of correlated facts brought out in these elaborate investigations, and how to compare the mechanical properties developed by the tests of strength with the physical properties found by the biologist, Mr. Philibert Roth, at Ann Arbor, Mich.

Between 5,000 and 6,000 tests of strength have now been made, and a good foundation laid for future work. One bulletin, describing the scope of the proposed investigation and the methods used, with illustrations of the machines employed, has been published and can be procured on application to Mr. B. E. Fernow, Chief of the Forestry Division, Agricultural Department, Washington, D. C. A great deal of interest in the work has been manifested, and many demands are already made for results. The first bulletin of results is delayed in order to fully mature a plan of publication

which can probably be adhered to. After this has once been done, the results will be given to the public more promptly.

Another special appropriation bill will probably be introduced into the next session of Congress for this work, and it is to be hoped it will fare better than its predecessors. There has been a wide demand for information concerning the strength of the famous Douglass or Oregon fir, which is now coming into general use as far East as Chicago, for bridge timbers especially, and of which Howe-truss railway bridges are now built up to 250 ft. long. No information has been obtained as yet on this subject. If any more of our readers are interested in learning more of the laws of the growth, strength, seasoning and preservation of timber they cannot do better than to try to interest their congressmen in the work now so well started in the Forestry Bureau. This is peculiarly a work for the Government to perform, as no private individual will or can devote the money and time to it that the importance of and wide interest in the results demand. The investigation so far made has been intelligently and conscientiously carried out and the foundation laid for further study, and the valuable results already secured prove the wisdom of Congress in the appropriations made for this purpose. Full knowledge is the foundation of all material and permanent progress in the arts and sciences; and where the attainment of this useful knowledge is beyond the reach of individuals, it is the duty and purpose of a parental Government at least to provide the means. It is the whole people, of which the Government is only the representative, that profit by investigation of the character of that here referred to.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Use of Highways for Water Mains.

The laying of pipes and hydrants, as authorized by the New York law, by a private corporation, in the highways of an unincorporated village, for the purpose of supplying the inhabitants with water, all of the inhabitants being entitled to the use thereof on the payment of a reasonable rate, is for a public use, even though no contract is or could be made with the municipality to supply it with water, and the highways may be so used on obtaining a permit from the village, as provided by the law. The fact that the village is unincorporated, and no contract can be made with it to supply it with water, and that the company cannot, therefore, exercise the right of eminent domain, is immaterial, since the right to so use the highways is not based on the right to condemn property, but on the doctrine applicable to the use of urban highways for such purposes. Such use of the highway does not impose an additional burden on the fee, for which the abutting owners are entitled to compensation. (Witcher v. Holland Water-Works Co. Supr. Ct. of N. Y., 20 N. Y. Sup., 561.)

Liability for Improper Sewer Construction.

Under the California statute providing that the Superintendent of Streets shall give bonds, on which, if he fails to see the laws, ordinances, orders and regulations relative to streets or highways executed, after notice of violation thereof, he shall be liable to any one injured in person or property in consequence of his official neglect; and section 11, providing that all persons directly interested in any work provided for in the act, feeling aggrieved by any act or determination of the superintendent relative thereto, shall appeal to the city council, and further providing that all the decisions of the city council shall in certain respects be final; the remedy of one complaining of the Superintendent's neglect in not seeing that a sewer was properly constructed in accordance with specifications, is not confined to appeal, and, there having been none, he can sue on the bond. (Goodsell v. Ashworth. Supr. Ct. of Cal., 31 Pac. Rep., 261.)

PERSONAL.

Mr. A. R. Turner, Jr., Chairman of the Water Board of Malden, Mass., has resigned.

Mr. Charles D. Colson has been appointed Water Commissioner of Holyoke, Mass., for three years.

Mr. H. S. Newkirk has been appointed Assistant General Superintendent of the Long Island R. R., with office at Jamaica, N. Y.

Mr. Nathaniel Roberts, Assoc. M. Am. Soc. C. E., for the past 21½ years Chief Engineer to the Wallis Iron Works, Jersey City, N. J., has resigned his position.

Mr. E. C. Kennan, formerly Resident Engineer of the Union Pacific Ry., at Denver, Colo., has accepted the position of Chief Engineer of the China Railway Co.

Mr. Farmer, of the well known signal manufacturing company of Saxby & Farmer, London, England, died in December last. The business will be carried on under the old name of the firm.

Mr. F. A. McClure has been re-elected City Engineer of Worcester, Mass. Mr. John S. Brady has been elected Water Commissioner, and Mr. H. B. Eddy, Superintendent of Sewers.

Mr. J. B. Miles, Civil Engineer, has entered into a business partnership with Mr. Frank C. Roberts, of Fourth and Chestnut Sts., Philadelphia, under the firm name of Frank C. Roberts & Co.

Dr. Alexander Shaw, Chief of the Horticulture Department of the World's Columbian Exposition, and one of the Board of World's Fair Managers, died at Denver, Colo., Jan. 4. He was born in 1815, at Camden, Del.

Mr. A. T. Dice, Supervisor of Signals on the New York Central & Hudson River R. R. has been appointed Assistant Division Superintendent of the Hudson River Division, and will continue to have charge of the signals.

Mr. J. P. Bradfield, Superintendent of the Buffalo Division of the New York, West Shore & Buffalo R. R., has been appointed General Superintendent of the New York, Ontario & Western R. R., with headquarters in New York.

Mr. Joseph Ramsey, Jr., General Manager of the Cleveland, Cincinnati, Chicago & St. Louis R. R., has assumed the duties also of General Superintendent, vice Mr. E. A. Peck, resigned, and has transferred his headquarters to Indianapolis, Ind.

Mr. Rollin H. Wilbur has been appointed General Superintendent of the Eastern Division of the Lehigh Valley R. R., vice the late Mr. H. Stanley Goodwin. He was for many years assistant to Vice-President Sayre, of the Lehigh Valley R. R.

Mr. M. T. Daly has been appointed Commissioner of Public Works of New York city, vice Mr. Gilroy, who is now Mayor. Mr. J. L. Florence has been appointed Superintendent of Streets and Roads, vice Mr. J. J. Ryan, appointed Deputy Commissioner of Street Cleaning.

Messrs. Booth, Garrett & Blair, analytical chemists, of 406 Locust St., Philadelphia, have established a department for the mechanical testing and inspection of iron, steel and other metals, including rails, structural and bridge material, railway equipment, water pipe, etc. Mr. F. H. Lewis, an expert in this specialty, has charge of this department, and a modern high-speed testing machine of 100,000 lbs. capacity has been added to the laboratory equipment.

Mr. M. A. Zook, formerly Division Roadmaster of the Alabama Great Southern Ry., has been appointed Engineer of Maintenance of Way, in charge of track, bridges and buildings, of the whole line. The offices of Resident Engineer, Inspector of Bridges and Buildings and Roadmaster have been abolished. They were held by Mr. M. Walshe, Mr. P. Nolan and Mr. J. C. Haugh, respectively, who have been connected with the road for 14 years and will probably be given other positions.

Mr. H. D. Lovell, Superintendent of the Bedford Division of the Pennsylvania R. R., has been promoted to Superintendent of the Cambria & Clearfield Division; Mr. Wilson Brown, Superintendent of the Belvidere Division, goes to fill the same position on the Amboy Division; Mr. A. P. Gest is promoted from the Frederick Division to the Belvidere, and Mr. A. W. Most, Superintendent of the Lewistown Division, will take charge of the Frederick Division.

Mr. Charles E. Alger, Division Engineer of the Boston & Albany R. R., died at his home in Springfield, Mass., Jan. 4. He was born in 1853, and was a graduate of the Worcester Polytechnic Institute, class of 1876. After working on the New York & New England R. R. for a short time, he entered the Boston & Albany R. R. engineer's office at Boston, Mass., in 1877, and in February, 1879, was transferred to Springfield, where he has since been as Division Engineer. He took particular interest in the abolition of grade crossings. The surveys and plans for grading needed in the separation of grades in Springfield and for the new station were largely under his direction. The other grade separations on his division have been large undertakings, and his last work was the preparation of plans for the Armory St. changes which were recently accepted by the city.

Admiral Pacoret Simonie di St. Bon. of the Italian navy, and Minister of Marine, died recently. He was one of the presidents of the Division of Marine Engineering and Marine Architecture of the Engineering Congress to be held at the World's Columbian Exposition. He was well known to naval architects and engineers as the originator of the great ironclads "Italia" and "Lepanto" of the Italian navy. They are practically floating batteries, regarded as the largest and most powerful warships in the world. They are over 400 ft. long, nearly 80 ft. beam, with a draft of 30 ft. and a displacement of nearly 14,000 tons. On the principal deck is an armored redoubt of oval form containing four Armstrong 100-ton guns. The main feature of this type of ship is the preponderance of armament to the sacrifice of armored protection to the hull.

NEW PUBLICATIONS.

THE MISSISSIPPI RIVER. From St. Louis to the Sea. Compiled from the Official Reports of Recent Surveys made by the United States Government, from the Reports of State Engineers and from Other Reliable Sources. By J. A. Ockerson, C. E., U. S. Assistant Engineer, assisted by Charles W. Stewart, U. S. Assistant Engineer. St. Louis, Mo. Oblong, 7×14 ins., 41 pp. of maps and table of mid-stream distances. $1.00.

This atlas of the Mississippi River from St. Louis to its mouth, is drawn on a scale of one inch to two miles, and is beautifully engraved in the style of the U. S. Coast Survey maps. With the maps are given the highest and lowest gage readings for all stations of record, the high and low water slopes, discharge at high and low water at various stations, the location of the present levee system, borings showing the character of the banks, the width, depth and curvature of the river, etc. It is practically a presentation in one volume and in handy form of the vast fund of information gathered by the Mississippi River Commission and the United States Engineers during the last twelve years, and scattered through so many official reports that it is inaccessible to the average seeker after this class of knowledge. The maps are thus official, to all intent and purpose, and this atlas cannot fail to be of special value to engineers and others taking an interest in this grand problem of river improvement, and to those who travel the river for business purposes or as mere pleasure seekers interested in knowing where they are. It is interesting to note that south of Cairo 20,000 sq. miles of country contiguous to the Mississippi River are subject to overflow, the state of Louisiana alone containing about 14,700 sq. miles of this area.

FREEHAND LETTERING. For Working Drawings. By Charles Benjamin Wing, C. E., Professor of Civil Engineering, Leland Stanford Junior University, Cal. Published by the author. Oblong, 12 mo. $0.40.

This book contains 22 excellent examples of lettering suitable for drawings of all kinds, and all capable of freehand application. The author suggests them as guides to the engineering student in "forming a hand" for freehand lettering, and in this connection gives some good advice as to the amount of time spent upon the lettering of a drawing and the commercial value of rapid, but neat work in this direction. Many of the alphabets presented are new to us, and the collection is sufficiently varied in style to permit almost any one to soon find the one best suited to his hand.

TRADE PUBLICATIONS.

A DISCUSSION OF GRANITE: Its Essential Properties, Natural Classification, Uses, Etc., with a Brief Discussion of the Distinctive Characteristics of Some of the Leading Granites, by John Glenville Murphy, E. M., formerly Territorial Geologist of Wyoming. Also report on the granite property of the Columbia Granite Co. by Ira H. Woolson, E. M. Middletown, Conn., The Columbia Granite Co., 16mo., leather, pp. 36.

This little book contains a very interesting discussion of the nature of granite, and clearly explains the reasons for the great variation in strength and durability of granite from different quarries. The fact in the book of greatest practical interest, however, is that the granite quarry which has been opened near Middletown, Conn., by the Columbia Granite Co., produces a stone which is from half to a third stronger than any granite on the market. Tests made on the Emery testing machine at the Columbia College School of Mines, showed a compressive strength of 31,659 lbs. per sq. in., as the average of 12 specimens, one of which failed at 34,075 lbs. per sq. in. To confirm these results, four specimens were tested on the machine at Watertown Arsenal, and an average strength of about 30,000 lbs., with an ultimate of 35,965 lbs. were shown. All the tests were made on 2-in. cubes. We believe this is a much higher crushing strength than has ever been recorded for any variety of stone. Baker gives the crushing strength of granite at 12,000 to 21,000 lbs. per sq. in. The extensive table of crushing strengths of English stones, given in our issue of Sept. 22, 1892, showed an average strength of 17,500 lbs. for granite, and a maximum of 21,162 lbs. Merrill, in his recent work,* reports over 120 tests of granite from all parts of the United States, and his highest values are only 26,000 to 28,000 lbs. for Minnesota granites. It would appear from all the available data that the Middletown granite is as strong a building stone as has ever been put upon the market.

CONSOLIDATED CAR HEATING CO. Catalogue 2.—This company is issuing a new edition of its catalogue of steam car heating equipment, and is sending it out in separate parts, each one devoted to some specialty of the company's manufacture. Parts II., III. and IV. thus far issued are devoted to the Sewall steam coupler, the McElroy "commingler," and the multiple circuit system.

SOCIETY PROCEEDINGS.

AMERICAN SOCIETY OF IRRIGATION ENGINEERS.—The first annual convention was held in Denver, Colo., in December, 1892. The society was organized at the time of the Salt Lake Irrigation Congress in 1891, by Professor Carpenter of the Colorado State Agricultural College, and others, and seems to have met a long felt want, for, in the first year of its existence, under the management of A. D. Foote, of

* "Stones for Building and Decoration," by Geo. P. Merrill; Wiley & Sons, 1891.

Idaho, as president, and C. L. Stevenson, of Utah, as secretary, the organization has grown to a membership of 130, including many of the prominent irrigation engineers of the West, and also has members from Mexico, Guatemala, Peru, France, Russia and other countries. About 50 members were present. The session lasted for three days, and the papers and proceedings will be published. Considerable time was taken in completing the orgainzation. The papers presented were "The Arid Land Problem," A. D. Foote; "The Operation of Irrigating Canals," E. D. Clarke; "The Disposal of the Sewage of Trinidad by Irrigation," Norval E. Wall; "The Movement of Water," A. P. Kittell, and "The Press and Irrigation," G. E. Bailey. Besides papers, discussions were held on different topics, as flumes, headgates, sandgates, etc. It is proposed to hold a meeting of the society some time during the World's Columbian Exposition, either just before or after the Engineering Congress. The officers elected for 1893 are as follows: President, Prof. L. G. Carpenter, Fort Collins, Colo.; Vice-President, Wm. Ham. Hall, ex-State Engineer of California; Secretary, J. S. Titcomb, Deputy State Engineer, Denver, Colo.; Board of Directors; C. K. Bannister, of Ogden, Utah; C. L. Stevens, Salt Lake City; C. Rockwood, Yuma, Cal., and A. D. Foote, Boise City, Idaho.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the meeting on Jan. 4, Mr. Cohen, president, in the chair, a paper by A. J. Grover, on "Flood Waves in Sewers, and their Automatic Measurement," was read by the secretary.

The experiments were made at Omaha, Neb., and the rainfall was also recorded. The rain gage employed was a modification of that of the U. S. Weather Bureau. There were two tops 0.8 in. diameter, the water from one being carried to a cylinder in which it was measured directly by a stick gage, and the water from the other going to an apparatus by means of which a continuous record was made automatically. The sewer gage consisted of a galvanized iron boat 3 ft. long, 1 ft. wide and 6 ins. deep, held in place near a manhole, but with entire freedom to rise and fall. This carried a longitudinal shaft on which at the stern of the boat was a screw 18 ins. diameter. The flow of the sewage caused this to revolve, and, by means of gearing, the motion was transmitted to an electric key and recorded. The rise and fall of the boat was also recorded. A storm shield was employed to prevent damage to the apparatus in case of an excessive flood.

The gage was fixed in an 8½-ft. circular sewer, which drained 2,100 acres. The longest dimension of this area was 11,000 ft., and the slopes varied from less than 1% to 18%. The sewers were not well proportioned for the work to be done, and at the junction of the two mains there was constant flooding. About 150 ft. below the gage the sewer was changed in form to a semi-elliptic invert, 16 × 5 ft., covered with steel beams. The grade at and for 418 ft. above the gage is .0057 to 1. There were 40,000 people in the district, which at 100 gallons per head would make 53.333 cu. ft. per day, to which springs along the line added somewhat. Two large breweries, a number of factories, etc., discharged into the sewer.

With a rainfall of 0.77 in., 0.3 of which came in 10 minutes, the summit of the flood was reached in 11 minutes after the dash was over. With a rainfall of 0.2 in. falling steadily for 30 minutes on the 2,100 acres, the summit of the wave will be at the mouth of the sewer when the rain ceases. In a subsequent rain coming in three dashes, as many distinct fluctuations were shown in the sewer, following quickly the successive falls of rain. A daily normal flow-sheet shows the relative daily velocity of the sewage and illustrates the regularity and precision of the gage, the noon stop of factories and elevators, and the greater use of water on Saturday, Monday and Tuesday.

Mr. Herschel thought the slip of the paddle wheel used for recording the velocity had been neglected in the computations.

Mr. E. B. Dorsey briefly described the harbor improvements at Tampico, Mexico, where two parallel jetties, 800 ft. apart, have been built, and a depth of 18 to 20 ft. of water obtained by natural scour of the channel, so that large vessels can now enter. The work is in the interest of the Mexican Central Ry., and is subsidized by the government. Mr. Cox gave an informal description of his circular slide rule for solving formulas for the flow of water in pipes, etc., which was described and illustrated in our issue of Dec. 22, 1892.

The annual meeting will be held Jan. 18 and 19, and at the meeting on Feb. 15 there will be a general discussion on Mr. Owen's paper on, "Some Disputed Points in Road Construction" (Eng. News, Nov. 24, 1892).

The following candidates were declared elected Members: John W. Alvord, Chf. Eng., Waukesha Hygeia Mineral Springs Co., Chicago, Ill.; James Francis, Agent and Engineer, Merrimack River Water Power, Lowell, Mass.; Alfred Rosenzweig, Mexico, Mexico; Henry G. Ruttan, Cy. Engr., Winnipeg, Man. Associate Members: Kennerley Bryan, Chf. Engr., Hale Elevator Co., Chicago, Ill.; S. B. Miller, Hoboken, N. J.

CONNECTICUT ASSOCIATION OF CIVIL ENGINEERS AND SURVEYORS.—The annual meeting was held at Hartford, Conn., Jan. 10, at which the minutes of previous meetings and the reports of officers were read. Officers were elected as follows: President, E. P. Augur; Vice-Presidents, F. W. La Forge and W. G. Smith; Secretary and Treasurer, W. B. Palmer; Executive Committee, E. P. Augur, C. H. Bunce, B. H. Hull and F. W. La Forge. The president and vice-presidents were re-elected. The address of the president was a review of the engineering work carried out in Connecticut during the year. The special committee on field work made a report on the question "What are the best methods for keeping field notes of various kinds of transit work?" The special committee on roads made a report on the question "What principles and considerations should govern an engineer in establishing grades for curbs and sidewalks on city or village streets, where the natural surface inclines considerably, and where streets intersect at distances apart of from 300 to 500 ft.?" The following papers were presented: "A Good Light for Night Work," E. P. Gardner; "Notes on Steel in Practical Construction," C. M. Jarvis; "Extension of the Outfall Sewer of the City of New London to the Channel of the Thames River," Geo. K. Crandall; "Drainage of the Wm. W. Backus Hospital, Norwich," Charles E. Chandler; "A Highway Layout, as It Is, and How It Might Have Been," W. H. Burnett; "The Naugatuck Storage Reservoir Dam," T. H. McKenzie.

The following members were present: E. P. Augur, Middletown; H. W. Ayers, New Britain; Geo. H. Bishop, Middletown; C. H. Bunce, Hartford; L. W. Burt, Hartford; R. A. Cairns, Waterbury; Edgar Clark, Putnam; W. S. Clark, Meriden; Geo. K. Crandall, New London; Robert Fenton, Willimantic; F. W. La Forge, Waterbury; H. G. Loomis, Hartford; J. M. McKenzie, Southington; T. H. McKenzie, Southington; W. B. Palmer, Bridgeport; R. J. Sabin, Pomfret; W. M. P. Shelton, Torrington; A. R. Wadsworth, Farmington; J. K. Wilkes, New Rochelle, N. Y.; W. H. Olmstead, East Hartford; H. L. Davis, Wallingford; E. N. Pike, Meriden; B. H. Hull, Bridgeport.

BROOKLYN INSTITUTE.—At the meeting on Jan. 9 Mr. J. Foster Flagg, M. Am. Soc. C. E., gave a lecture on "The Disposal of Sewage by European Systems," describing works visited by him recently. The Shone hydro-pneumatic system (Eng. News, Dec. 29, 1892), was described, and the various methods of disposal: 1, discharge of crude sewage into water courses, lakes or harbors; 2, chemical precipitation; 3, broad irrigation; 4, intermittent downward filtration, generally preceded by natural or chemical precipitation, which, however, is not necessary with a proper construction of filter bed. London has works on the north and south sides of the Thames, the latter not yet completed. At the former about 140,000,000 U. S. gallons are treated daily by 7,000,000 gallons of clear lime water and 16,000 lbs. of copperas dissolved in water. There are 32 masonry tanks 100 × 32 ft., with an aggregate capacity of 24,000,000 gallons. The sludge is carried out to sea in tank steamers of 1,000 tons capacity. The south side works will increase the capacity of the works to 230,000,000 gallons daily. A vote of thanks was tendered Mr. Flagg. L. Duvinage, Secy.

ENGINEERS' CLUB OF ST. LOUIS.—At the meeting on Jan. 4 the paper on "The Recent Survey of St. Louis: Its Methods and Results," was discussed. The use of the survey in regard to laying out city lots was discussed, and Mr. Ferguson spoke of the desirability of having a survey advance ahead of the growth of the city, while others spoke of the difficulty of re-locating the old points. Mr. Ferguson read a discussion on the subject. The difficulties in handling the instruments and obtaining accurate results were gone over and the troubles pointed out. Sketches were recommended as an aid in working up the notes. Professor Johnson read a paper in which the question of errors in precise leveling was gone over. Mr. Ockerson described the methods and results obtained on the river work. Mr. Jolley described some of his difficulties with the stadia rod and level.

Mr. Ockerson presented to the club a copy of his book, "The Mississippi River from St. Louis to the Sea." Arthur Thacher, Secy.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—The next meeting will take place at the Kimball House, Atlanta, Ga., Jan. 19. The subjects for discussion will be as follows: 1, "The Best Course to Pursue to Reduce Oil Consumption in Engines and Cars," T. W. Gentry, A. T. Hooker, and Jas. Cullen; 2, "Driving Boxes.—Best Material and Shape in Order to Prevent Breakage and Wear. Is the Solid Box Suitable for Heavy Engines?" A. W. Gibbs, Jas. Meehan and F. E. C. Davis; 3, "Stay-Bolt Inspection," R. P. C. Sanderson, W. H. Owens and F. H. McGee; 4, "The Best Material for Piston Rods and Mode of Fastening Rod to Cross-Head and Piston-Head," G. W. O'Brien, Geo. D. Harris and Wm. Rutherford; 5, "The Experience of Members on Compound Engines." The committee, W. H. Thomas and Pulaski Leeds, on, "Repair Work on Large Systems, and Location of Plants for Same," is expected to report. S. A. Charpiot, Secy.

ENGINEERS' CLUB OF PHILADELPHIA.—Meeting of Dec. 17, President James Christie in the chair. Forty-five members and visitors present. Mr. Edward Hurst Brown read a paper on "Paint as Used on Engineering Constructions," in which he described the composition of paints for use on wood and metal surfaces, with particular attention to the proper material to use on structural iron work. The secretary opened a discussion, "On High Speed on Railways," by calling attention to the run of a Philadelphia & Reading express train on Nov. 18, between Philadelphia and New York, as recorded in Engineering News of Dec. 8 and 22. It made the highest record yet attained, viz., 97.3 and 94.73 miles per hour, the highest previous record having been 91.7 miles per hour, made last February by the same engine, which broke the earlier record of 90.5 miles per hour, made by an engine and one car on the same road in August, 1891. Mr. John C. Trautwine, Jr., predicted that when 80 or 100 miles per hour was an everyday affair, we would probably find the cars suspended from, instead of supported by the rails, and instead of heavy trains, light single vehicles would follow each other at short intervals.

L. F. Rondinella, Secretary.

ENGINEERS' CLUB.—The annual report shows that the membership of the club has been increased to a total of 601, of which 292 are resident and 309 are non-resident. The total receipts were $14,577, while the expenditures for all purposes amounted to $37,712, leaving a balance of $6,805, as compared with $3,571 last year. The question of renewing the lease of the present club house at No. 10 W. 29th St., New York, or the selection of other quarters is one to be considered during the coming year.

David Williams, Secy. J. F. Holloway, Pres.

COMING TECHNICAL MEETINGS.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Jan. 17. Secy., R. H. Clark, Pittsburg.
WESTERN RAILWAY CLUB.
Jan. 17. "Wheel Flanges," G. W. Rhodes, C. B. & Q. Ry. Secy., C. F. Street, Rookery Building, Chicago.
BOSTON SOCIETY OF CIVIL ENGINEERS.
Jan. 18 Secy., S. E. Tinkham, 36 Broomfield St.
MICHIGAN ENGINEERING SOCIETY.
Jan. 17, 18, 19. Annual meeting at Lansing, Mich. Secy. F. Hodarman, Climax, Mich.
ENGINEERS' CLUB OF ST. LOUIS.
Jan. 18. Secy., Arthur Thacher, Odd Fellows' Building.
IOWA CIVIL ENGINEERS' AND SURVEYORS' SOCIETY.
Jan. 18. Annual meeting, Court House, Des Moines, Ia. Secy., Seth Dean, Glenwood, Ia.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 18, 19. Annual meeting. Secy., F. Collingwood, 127 East 23d St., New York.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Jan. 19. Atlanta, Ga. Secy., F. A. Charpiot, Macon, Ga.
NEW YORK RAILROAD CLUB.
Jan. 19. Secy., H. G. Prout, 73 Broadway, N. Y.
ENGINEERS' CLUB OF CINCINNATI.
Jan. 19. Secy., J. F. Wilson, 24 W. 4th St.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Jan. 19. Secy., C. F. Franson, Portland Block.
TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
Jan. 20. 201 Washington Building.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 20. Secy., C. H. McLeod, Montreal, P. Q.
CENTRAL RAILWAY CLUB.
Jan. 24. Secy., Geo. H. Angell, 35 Jacobson Block.
DENVER SOCIETY OF ENGINEERS AND ARCHITECTS.
Jan. 24. Secy., Parker N. Black, Capitol Block.
INDIANA ENGINEERING SOCIETY.
Jan. 24, 25, 26. Annual meeting at South Bend, Ind. Secy. E. H. Vawter, Lafayette, Ind.
WESTERN SOCIETY OF ENGINEERS.
Feb. 1. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Feb. 6. Secy., C. L. Annan, City Engineer's Office.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Feb. 3. Secy., E. K. Smoot, 503 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
Feb. 3. Secy., O. Von Geldern, 719 Market St., San Francisco.
NORTHWEST RAILROAD CLUB.
Feb. 4. Union Station, St. Paul.
MONTANA SOCIETY OF CIVIL ENGINEERS.
Feb. 4. Secy., F. D. Jones, Helena.
SWEDISH ENGINEERS' CLUB.
Feb. 4. Secy., P. Valentine, At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago Secy., John Eriason.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
Feb. 8. Wichita, Kan.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
Feb. 7. Secy., Chas. S. Howe, Case School.
ENGINEERS' SOCIETY OF PHŒNIXVILLE.
Feb. 7. Secy., W. Halliburton.
ENGINEERS' CLUB OF MINNEAPOLIS.
Feb. 9. Secy., F. W. Cappelen, 1628 Hennepin Ave.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Feb. 9. Secy., Edward Mead, Norton Building.
ENGINEERING ASSOCIATION OF THE SOUTH.
Feb. 9. Secy., O. H. Landreth, Nashville, Tenn.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
Feb. 10. Secy., D. W. Meeker, St. Paul.
WISCONSIN POLYTECHNIC SOCIETY.
Feb. 13. Secy., M. F. Schinke, City Hall.
ENGINEERS' CLUB OF KANSAS CITY.
Feb. 13. Secy., Waterman Stone, Baird Building.
ATLANTA SOCIETY OF CIVIL ENGINEERS.
Feb. 14. S. W. Spear, E. Buffalo, N. Y., Iron Works.
NORTHWESTERN SOCIETY OF ENGINEERS.
Feb. 14. Secy., D. W. McMorris, Burke Block, Seattle, Wash
ENGINEERS' CLUB OF PHILADELPHIA.
Feb. 21. 1122 Girard St. Secy., L. F. Rondinella.
AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 21, etc. Annual meeting, Montreal, Que. Secy., R. W Raymond, 6 Burling Slip, New York, N. Y.
NEW ENGLAND RAILROAD CLUB.
March 8. Secy., F. M. Curtis, O. C. R. R., Boston.

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AND
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D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

Chicago Office: Monadnock Building.
F. A. PECKHAM.....MANAGER

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ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

We regret to state that, in announcing the award of our premium to the thesis entitled "The Variation of the Co-efficient of Friction with Different Loads and Bearing Metals" (Jan. 5, 1893), which proved to be the work of—

Joseph Kerber Lima Ohio
Robert L. Mickle Millville

we misread and misannounced the first name as being that of "Joseph Kerber," when it was intended by the writer to mean "Kuhn."

The above signature was read "Kerber" by two persons at the time of opening the letter, and the name "Kerber" appears in the New York City Directory. After receiving the above correction, the signature was passed about the office to seven different persons, all with large practice in reading manuscript, and was read by them in five different ways, as follows: "Kerber," "Kuber," "Kuher," "Kerhn" and "Kuhn," only one of the seven giving the latter reading.

We note these facts to enforce one moral which writers for the press almost universally neglect, while they should always remember it. It makes little difference how the words of an ordinary sentence are written, since the word they are meant to represent, or an equivalent which will do just as well, can be guessed at from the context. But names of persons or places, algebraic symbols and foreign or unusual words which are not helped out by the context, if in themselves obscure, should be written with especial care to make each letter plain—and they almost never are.

We publish in our correspondence columns a letter signed by three most reputable engineers and prominent members of the American Society of Civil Engineers, to which the contents refer. The letter has to do with questions which have already been raised in this journal, all the facts so far made public being given in our issues of Aug. 18, Sept. 29, Nov. 10 and Dec. 15, 1892. While the occasion for such a communication can only be regretted, the charges made are too serious and the ultimate effect of non-action too important in its bearing upon professional ethics to allow the controversy simply to die out by default. The engineer chiefly interested owes it to himself and to the profession to which he belongs to demand at once from the Board of Direction of the American Society of Civil Engineers the fullest investigation into the charges made by fellow-engineers; and he should make this demand before he formally accepts the seat in that board to which he will probably be elected. In this way only can he obtain full vindication and restoration to unassailed professional standing. In the interest of all concerned this official investigation should be full, sweeping and fearless, founded upon full information of all that bears upon the case as presented by the several parties to the dispute. This means considerable trouble to the board; but a decision so made would establish a precedent among engineers that could not fail to be beneficial to the profession throughout the country. We trust that this may be the final outcome of this case.

Since the above was in type we have received the following telegram from Mr. Fanning, dated Minneapolis, Jan. 10, 1893:

Proof just received. I have wired the signers that the proof makes assertions that are untrue, and that they have evidently been deceived. The drawing which you published Sept. 29 last, was not used by me and I do not remember having seen the drawing from which it was reproduced. A sketch similar in part was used and explained verbally to the Board.

We infer from the preceding that a specification of the errors of the letter, and of the points of difference between the diagram published and the diagram used, is to follow; and until this is before him every reader should suspend his judgment. It is but just to ourselves to add, however, that we made every effort to enable Mr. Fanning to reply in the same issue to the original charges or protest, and to point out any errors in the cuts or text, as will be seen by referring to our issue of Sept. 29. Had he done so it would perhaps have saved the subsequent misunderstanding of others to which he objects in the above telegram.

The capacity of our esteemed contemporary, the London "Engineer," for blundering over things American is again illustrated in its issue of Dec. 9. The perennial conflict over English and American locomotives and railway practice is now raging in its columns, as it has been at intervals for years past, and although the controversy in itself has no interest to Americans, and is not followed here, it may contribute a little to the gayety of nations to show the grounds advanced by the "Engineer" for being "certain" that English railway managers have "nothing to learn from the United States." One "W. M. A.," has been adducing in behalf of American practice the now famous Empire State Express, of the New York Central & Hudson River R. R. The "Engineer" remarks in reply:

It will, perhaps, come as a surprise to him to learn that the work done on the Great Northern is very much in excess of that on the American road. The engine and tenders working the latter weigh 92 tons, and haul a train weighing 143 tons. But the Great Northern engines and tenders weigh 85 tons, and haul in summer trains weighing 240 tons; that is to say, 16 coaches weighing, without passengers or luggage, 15 tons each, and in winter the load is 12 coaches, or 180 tons. The lightest express trains on the Great Northern weigh almost as much as the heaviest on the American road, and the speeds are certainly not inferior on the former.

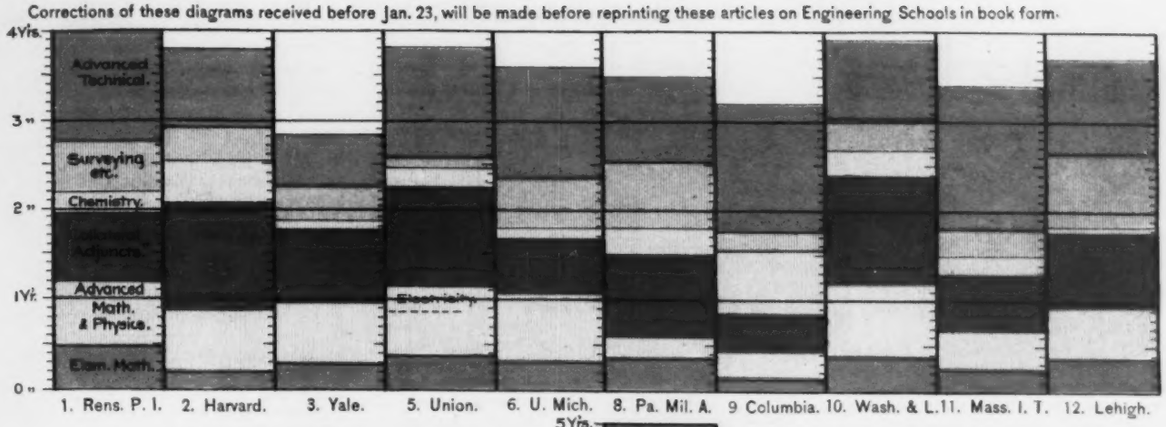
The last three lines of this quotation are delightfully absurd when contrasted with the facts. The Empire State Express is, in the first place, much the lightest of any fast express over the New York Central, and, in the second place, much the fastest train in the world, even without considering the extraordinary length of its run. Therefore, it cannot be claimed either for the Great Northern or any other line that its speeds are "certainly not inferior" to it. As for weights, every day in the year the 6 p. m. express over the New York Central, running through to Chicago in but little over 25 hours, leaves New York with 10 to 12 heavy cars behind it, mostly sleepers, and weighing from 350 to 420 tons (of 2,000 lbs.) behind the tender. This train makes 60 miles per hour or more on parts of almost every day's run; and there are several others comparing fairly with it. The Great Northern train weights of 240 tons (of 2,240 lbs.; 269 net tons) in summer and 180 tons (201.6 net) in winter, are not only far outdone by all but one or two of the New York Central's expresses, but are outdone by one or more regular expresses on all American lines of any prominence, since such trains are not here considered heavy trains at all. In the light of these facts, how absurd is the statement that "the lightest express trains on the Great Northern weigh almost as much as the heaviest on" the New York Central!

Prof. Silvanus P. Thompson, the author of several English works on electricity, writes a very intemperate letter to the London "Electrician," complaining that an American is about to publish a translation of a Latin treatise that he has been at work upon for some years, and attempts to lessen the value of the American book by scurrilously assailing the American firm that is to publish it. The treatise in question is Gilbert's "De Magnete," written over two centuries ago, and now of very considerable historic value in connection with the study of progress in electrical science. Professor Thompson and his co-laborers had organized a "Gilbert Club," it seems, with the intent of issuing an elaborate and costly edition de luxe of "De Magnete." But they have taken their time about it, and find their work far from complete when this unwelcome news comes from the United States. In his letter Professor Thompson fails to find any reason why an equally learned American should not translate this almost forgotten author of several centuries ago; so he weakly attempts to injure the character and sale of the forthcoming work by assailing the character of the house that is to publish it. As to this assault, it is enough to say that the American publishers are John Wiley & Sons, of New York, a firm founded a century ago, and in all these years enjoying an enviable reputation for the character of its published works and its just dealing with authors. The real trouble with the "Gilbert Club" is probably the fact that John Wiley & Sons have copyrighted their editions of "De Magnete" in England; and it is consequently safe to say that there will be little occasion for the issue of the proposed edition de luxe, and the English translators might as well at once and permanently cease their seemingly too arduous task.

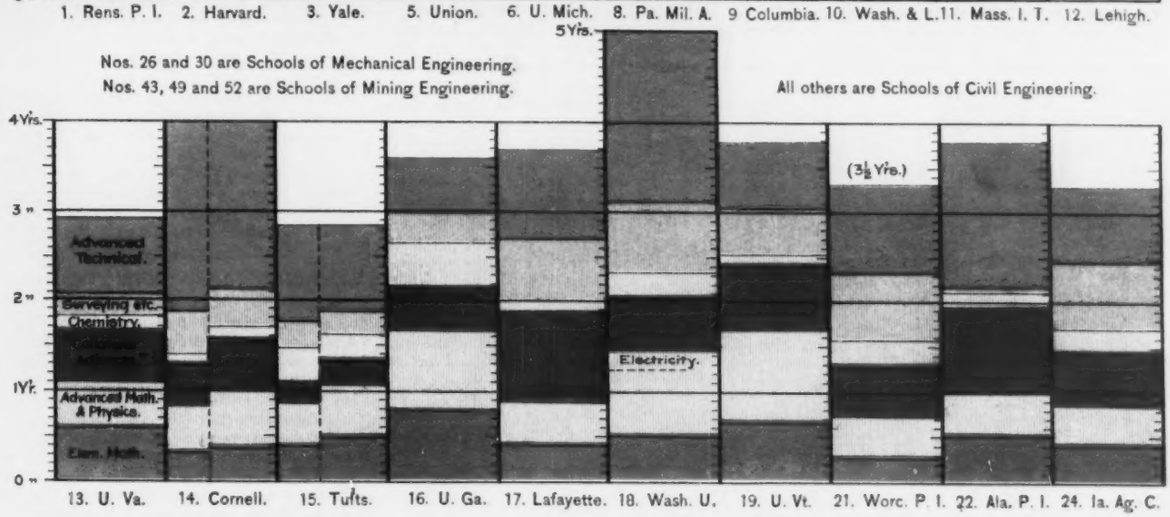
(Reprinted from editorial page of Engineering News of Jan. 9, 1892.)

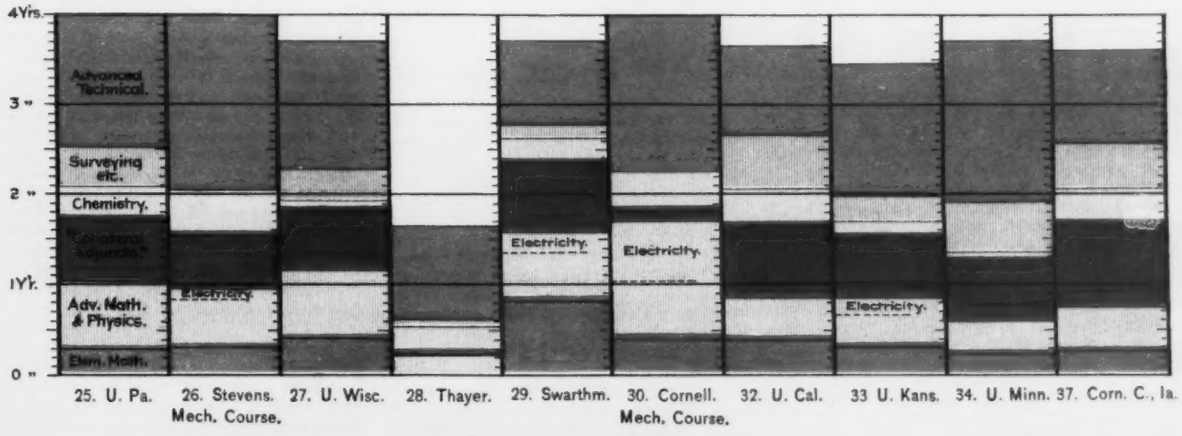
Another year has passed and gone, and the "Brooklyn Bridge question" stands exactly where it did a year ago, and four years ago, as respects any overt attempts to increase its overburdened transit facilities. Two or three buildings have been bought and torn down, and a languid beginning made toward getting ready to do something some of these days, but on the ground that money or condemning powers or what not are lacking, everything is now at a standstill. It is all but impossible to suppose that these delays could have occurred if there were any real willingness or desire to put to the cruel test of experience the alleged "adopted plans." Agitation of the matter, due to the plain necessity of some large expansion of facilities, began with 1886. On Feb. 23, 1888, the first Board of Experts reported. The report was not to the Trustees' liking, and they proceeded at once to adopt what their Board of Experts had condemned, and to condemn what it had recommended. Nevertheless they did nothing to carry out their adopted plans, until on May 12, 1890, they appointed a second Board of Experts, which reported Jan. 10, 1891, that the trustees were all right and the former Board of Experts all wrong, and that the old "adopted plans," without any modifications of moment, would in fact result in much more than doubling the existing capacity. The arguments which induced this conclusion are not for us to judge. If the press reports were correct, each member of the Board had 4,000 good reasons for reaching it, if he had no others, for each was paid $5,000 for his opinion in favor of the trustees' adopted plans, whereas the former Board of Experts were paid only $1,000 each for an investigation and report at least as long and as elaborate, by at least as eminent engineers. Fortunately the appeal to experience, however it may be delayed, cannot be escaped from. Pending that appeal, the last word has been said on the subject. We have predicted, and now again predict, what will be the result of that appeal. No increased capacity of any amount will be obtained; no relief from the existing pressure, even for a day, will result; but there will result a decided increase in the tendency to delay and to accident. When the appeal to this infallible court of last resort begins, we shall have pleasure in laying before our readers, from time to time, in contrasting columns, what was promised and what has been accomplished. Until then, we shall content our-

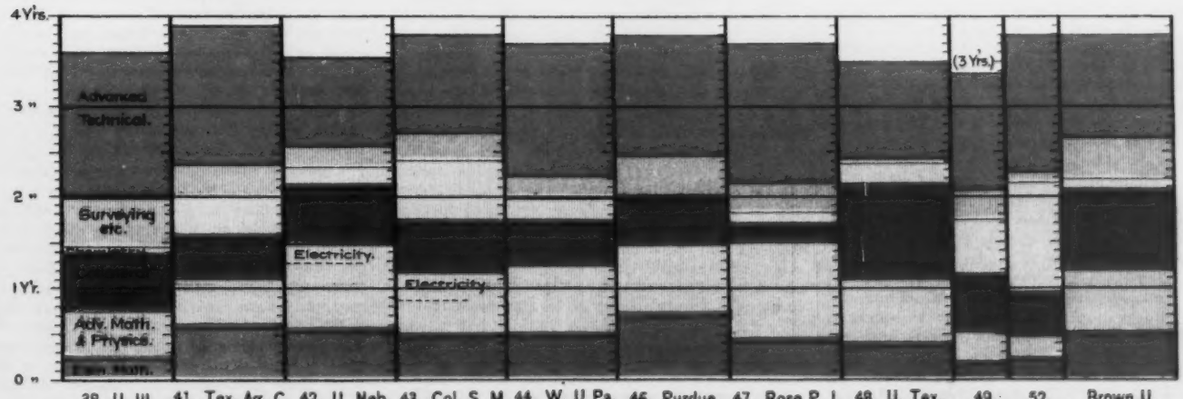
Corrections of these diagrams received before Jan. 23, will be made before reprinting these articles on Engineering Schools in book form.



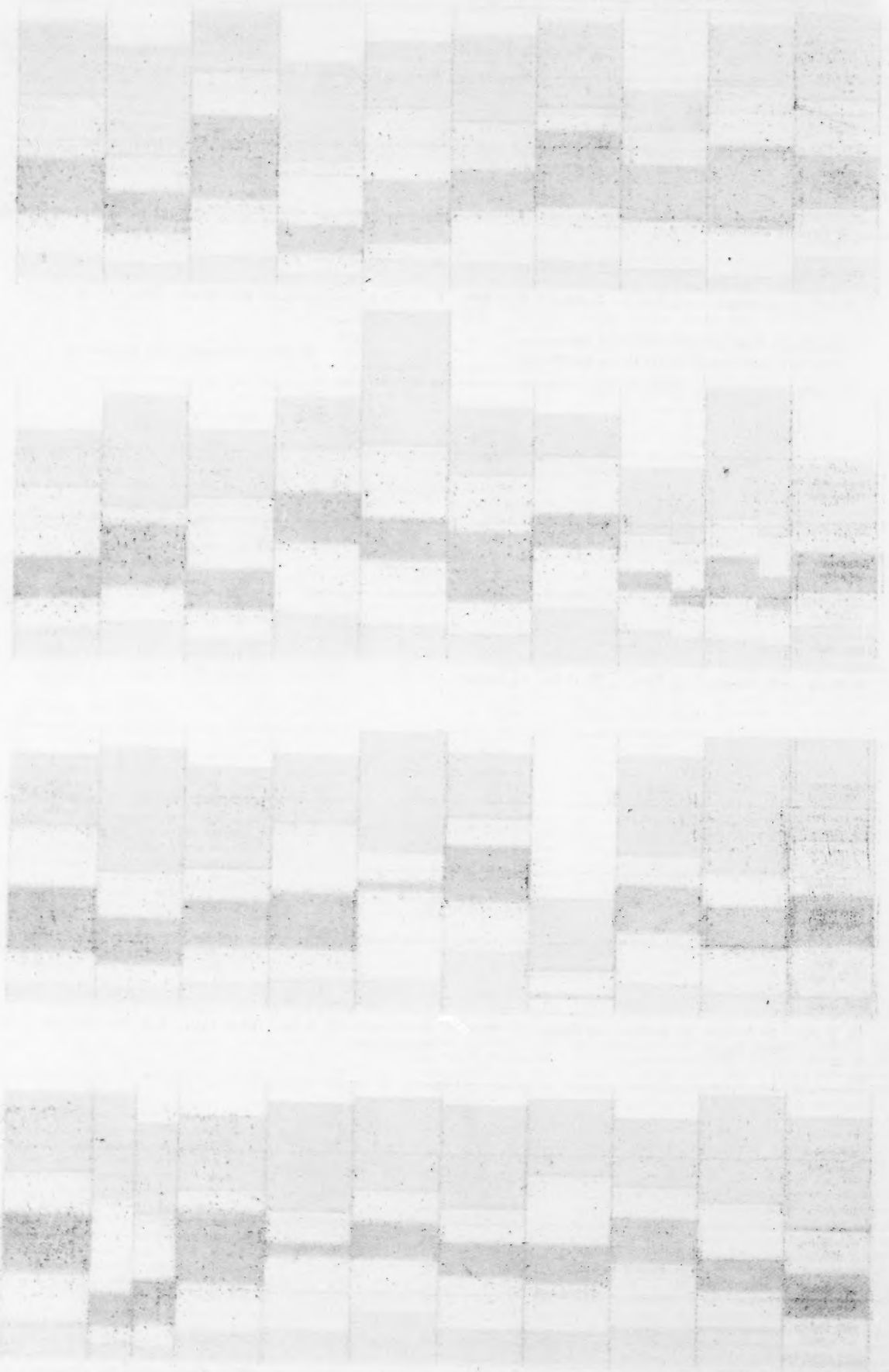
Nos. 26 and 30 are Schools of Mechanical Engineering.
Nos. 43, 49 and 52 are Schools of Mining Engineering.
All others are Schools of Civil Engineering.







Diagrams showing the Total Length in Years of Forty Weeks of the Courses in Engineering of 41 Engineering Schools and the Distribution of This Time to Six Main Classes of Studies.



selves with calling attention, in some early issue of each succeeding year, to the fact that the appeal has not yet been hazarded.

The situation still remains, in January, 1893, so nearly at it was in January, 1892, so far as any overt steps toward the introduction of the proposed new system of operating are concerned, that we cannot better fulfill the promise at the end of the above article than by reprinting the article itself. This we shall continue to do at the beginning of each succeeding year, until the alleged new system is either put to the test of practical operation or formally abondoned.

The crushing strength of granite, the strongest of building stones, is commonly rated at 12,000 to 15,000 lbs. per sq. in., when tested in 2-in. cubes, and only the hardest and toughest of the commonly used varieties reach a strength above 20,000 lbs. Recently, however, a granite quarry has been opened on the Connecticut River, the product of which shows a crushing strength averaging some 30,000 lbs., or nearly double that of the average granite in the market. Samples of this stone tested at the Watertown Arsenal have shown a maximum ultimate strength of 35,965 lbs. per sq. in. If any of our readers know of a record higher than this for a building stone of any sort, we trust that he will report it, as a fact of general interest.

TESTS OF THE PARSONS STEAM TURBINE.

We report in this issue the latest developments in steam turbines, a form of motor which seems to promise much in the direction of a more economical use of steam, and especially in the extension of its use to places where the lightest possible form of prime mover is required. Our former article on steam turbines (Feb. 27, 1892) aroused much interest; but one engineer recently expressed to us his doubt of the correctness of the tests which we described. A few words therefore as to the evidence for and against the correctness of the tests and the reliability of the report published on another page will enable the reader to form his own judgment in this matter.

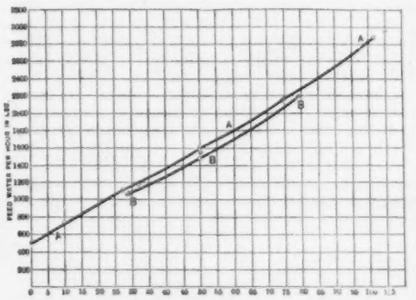
Both the former tests and those reported in this issue were made by Prof. J. A. Ewing, a Fellow of the Royal Society and Professor in Cambridge University. The former tests we severly criticised at the time, for while on its face the report bore every evidence of being correct and authentic, the tests were made under circumstances quite unfavorable to the turbine, and which were strongly emphasized in the report, the inference being drawn that a much higher economy was obtainable under more favorable conditions. As we then said, a test made and reported in such a manner always deserves criticism. A test to show the best results of which a machine is capable, should be made with all conditions as favorable as possible, and should not be made until such favorable conditions are secured.

Professor Ewing's report of the second series of tests, the substance of which we reprint in this issue, is, on the whole, a much more creditable document than his previous report. It bears every evidence of being a record of actual results obtained from careful and accurate testing. It is not until we come to Professor Ewing's summing up and comments on the result of his tests that we find an attempt to exaggerate the facts. Here, however, most serious criticism must be made. In the first place, Professor Ewing claims that as the boiler and steam pipe were leaking at the rate of 90 lbs. per hour, which was 3% of the steam consumption of the turbine at full load, therefore the economy found in the tests should be increased 3% at full load and 6% at half load. Certainly a steam pipe and boiler leaking at such a rate was in a poor condition for use in an important test, but some excuse may be possible for this. It is difficult, however, to imagine any possible excuse for a paragraph of Professor Ewing's report in which he computes the steam consumption per I. HP. from the consumption per E. HP. A fair average of the most economical results was 20.9 lbs. of steam per E. HP. To obtain the steam consumption per HP. of mechanical work done on the turbine blades Professor Ewing says:

> The curves of the diagram (reproduced herewith) are nearly straight lines, and by prolonging them backward to meet the base line produced, it appears that the idle work—that is to say, the work done without useful output—was equivalent to 27 K-W., or 36 HP. The effective work at full load, the equivalent of 100 K-W. per hour, was 134 E. HP. Hence, if the idle work had the same value at full load as when the machine was running light, the total work done by the steam at full load would be 170 HP., and the effective work (134 HP.) would be 79% of the total. But the idle work certainly increased when the machine was loaded, and it will be nearer the truth to assume that the effective work was not more than 75% of the total work. This would make the total work about 179 HP. On this basis, a consumption of steam at the rate of 28 lbs. per K-W. is equivalent to 13.7 lbs. of feed water per I. HP. hour, and 27 lbs. per K-W. is equivalent to 15.1 lbs. per I. HP. hour. Similarly the consumption at half load is equivalent to about 17 lbs. per I. HP.

That the above method of finding the percentage of work absorbed by the turbine and dynamo is wholly incorrect and misleading is apparent in slight examination. It amounts to saying that the steam run through the turbine when all the load is thrown off fairly represents the steam required to overcome the friction of the machine; but even from this untenable standpoint, the result obtained is far out of the way. If this method of computation were correct, the whole machine at full load would absorb no less than 46 HP. in friction and internal resistance. This represents energy enough to actually melt both turbine and dynamo in a short time. The machine would be absolutely unworkable under such conditions.

Certainly the occurrence of such a blunder or worse in a report of this sort throws a discredit on



Trials of Parsons' Steam Turbine and Dynamo, August, 1892.

AA—Steam superheated to about 400° F.
BB—Steam superheated to 465° F.

the whole series of tests which not all the reputation due to an "F. R. S." and a professorship in Cambridge University can dispel. On the other hand, these turbines and dynamos are being installed in a central electric light station at Cambridge, if we can believe our English contemporaries of the best standing, all of whom, as well as some on this side of the water, print Professor Ewing's report entire, without the slightest comment on the gross error above noted. The Parsons turbines have also been used quite extensively for isolated lighting plants, and furnished light for the Newcastle Exposition some years ago. There is no reason in theory why a steam turbine should not be made of high efficiency, and the details of the Parsons turbine have certainly been worked out with a high degree of ingenuity.

Again, Mr. C. A. Parsons, the inventor and manufacturer of these turbines, is the younger son of a peer, which may count for something or nothing as respects his character, and is an Associate of the Institution of Civil Engineers, which ought to count for considerable. Certainly, he should be above sending out any report of tests on his motor which are not accurate and correct in all essentials, for such work must inevitably react upon its author.

Taking all these facts into consideration, we are inclined to attach considerable importance to the remarkably good results reported elsewhere, and hope that the element of doubt which still attaches to them may be dispelled by further tests made by experts of the highest standing, under conditions which do not call for so many dubious allowances.

THE EXPANSION AND CONTRACTION OF ICE.

That ice on the surface of a lake may, by its movement of expansion or contraction under changing temperatures exert an enormous force, sufficient to move heavy masonry bridge piers, is a fact not generally known, and one on which technical literature, so far as we know, gives no information. On another page of this issue we print the substance of a recent paper and discussion before the Canadian Society of Civil Engineers, in which some remarkable instances of this action were recorded, and the laws governing it were pretty well defined. So large a proportion of our engineering works are exposed to injury by ice that this information is well worthy of careful examination. The necessary conditions for such a movement of the ice as would give cause for alarm appear to be that the ice shall have a thickness greater than 3 to 5 ins., that it shall have little or no snow on its surface, and that the temperature of the air shall fall considerably below the freezing point. A succession of days when the thermometer ranges 20° to 40° lower during the night than during the day is the condition most favorable for great movement. It is of course necessary that a considerable expanse of ice should be present in order to produce any considerable movement; but in one case cited, a masonry bridge pier, weighing about 1,000 tons, was tipped 2 ins. out of plumb by the pressure of a sheet of ice only 150 ft. in width.

The most interesting case of ice pressure reported, and one which excited a brisk discussion before the Society, was the movement of the piers of a highway bridge at Belleville, Ont., built in the winter of 1890-1 across the Bay of Quinte. The masonry piers of the bridge were founded on piles driven through 20 ft. of water and some 20 to 40 ft. of mud to rock. The movement of the ice following the formation of a crack, which extended across the bay, carried the bridge piers with it, forcing them 2 to 12 ins. out of line, the pile supports bending with the side strain. When the ice was cut the piers came back to about their former position.

This structure was severely criticised by Mr. E. P. Hannaford, who held that the piers should have been protected by ice breakers at each end, and should have been made massive enough to withstand any ice thrust. The engineer of the bridge, Mr. C. H. Keefer, and Mr. Walter Shanly, who was called in consultation by the bridge managers, defended its design. They stated that to have carried the piers to solid rock would have made the enterprise financially impracticable. Further, they showed that since the thrust was as likely to come from one direction as from another, the ice breaker would have to be of conical form, surrounding the pier. To protect the bridge from further injury from ice movement, they had a clear channel, about 3 ft. wide, cut and kept open across the bay parallel with the bridge and on each side of it. The cost of this is very small, and it gives perfect protection.

That this method of protection against ice movements of the sort referred to is far preferable to building piers massive enough to withstand the thrust will probably be generally agreed by engineers. If cutting the channel by hand proves expensive, a rotary cutter, driven by a portable steam engine, could easily be devised.

On the other hand, the man who sets out to build a masonry pier in deep water strong enough to withstand the expansive force of an ice field, exerted from any direction, has a large contract on his hands. Sloping ice breakers at the water's edge against which the ice may run up and fracture work well enough where the shove is always from one direction, and the ice may run up on a sharp edge. But if the ice may move against the pier from any direction, or, say, from any direction within an angle of 90° at each end of the pier, what form shall the ice breakers take?

It must be kept in mind in discussing this question that the action of ice under consideration is wholly different from the action exerted by floating fields of ice, against which engineers are accustomed to guard. The ice breaker on the nose of a bridge pier presents a sharp edge, up which the moving ice is carried by its momentum and the pressure of the current, and on which it is easily broken. But a masonry pier standing in a lake will have the ice frozen solidly to it, and the adhesion of ice to a surface of stone is little if any less than its crushing strength. Thus, even if the pier be protected by a sloping surface at the water's edge, the adhesion of the ice to the stone may be

so great that it will exert against the pier a thrust due to its full crushing strength before it will fracture. It follows from this that safety against thrusts due to the expansive force of ice can only be provided by making the moment of stability of the pier sufficient to withstand a force equal to the unit crushing strength of the ice, exerted over an area equal to the cross-section of ice sheet in contact with the pier.

It becomes then important to know the crushing strength of ice under the conditions assumed. In the discussion on this subject before the Canadian Society of Civil Engineers, Mr. E. P. Hannaford referred to experiments made by Sir Casimir Gzowski, President of the Canadian Society in 1871, which determined the crushing strength of ice at 208 lbs. per sq. in. Hence, said Mr. Hannaford, "what has to be done (to build a pier which will resist ice thrust) is to oppose ice pressure by sufficient resistance to crush it, viz.: 208 lbs. per sq. in." This was repeated by other members in the discussion, and appeared to be accepted as correct.

But this low value for the crushing strength of ice is not corroborated by other experiments. Experiments by Col. Wm. Ludlow, U. S. Engineers, made in 1880,* showed that ice crushed at pressures of 100 to 1,000 lbs. per sq. in., varying greatly with its internal structure and the purity of the water from which it was formed, and also with its temperature. Ice of the clearest and most compact structure, according to Colonel Ludlow, has a maximum crushing strength of about 1,000 lbs. per sq. in. Ordinary clear ice, such as forms on the upper Delaware River, will, under certain conditions, resist a pressure of 700 lbs.; and ice in the condition found on the Delaware near its mouth crushes at 400 lbs. or less, being more or less disintegrated by exposure to sun, air and salt water.

From the results of those experiments Colonel

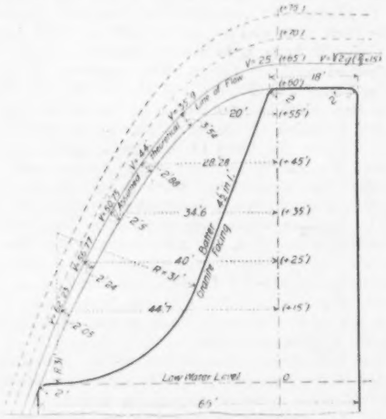


Diagram Showing Flow of Water Over Dam with Wide Horizontal Top; From Mr. J. T. Fanning's Report on Austin Dam. (Eng. News, Sept. 29, 1892.)

Ludlow adopted 400 lbs. per sq. in. as the crushing strength to be used in computing the resistance necessary to be provided in constructing piers for an ice harbor at the head of Delaware Bay. Certainly if this was a correct value for the ice encountered at this place, a much higher crushing strength should be assumed for the ice which forms on the lakes and rivers of Canada and the northern United States.

We know of no other experiments on the strength of ice which appear so worthy of reliance as those of Colonel Ludlow. Some German experiments, reported in our issue of Dec. 26, 1885, were made on cubes with 2 to 3 in. sides and gave a much lower value, not far from that given by Colonel Gzowski. Colonel Ludlow's experiments were made on cubes with 6 in. to 12 in. sides, and it is probably the difference in size of the test pieces which accounts for the difference in results. As ice thrust due to expansion and contraction only becomes serious when the ice sheet is of greater thickness than 5 ins., it is plain that the results from large test pieces are those which should be used as a guide to practice. When these facts are taken into consideration, the wisdom of protecting a structure exposed to thrust from expanding and contracting ice by cutting channels around it is evident. Perfect safety can be secured in this manner; whereas, if it is attempted to provide sufficient resistance in the structure to crush the ice against it, either the designer must provide an enormous surplus of strength, or there must be some uncertainty as to the result when the irresistible force meets the immovable body.

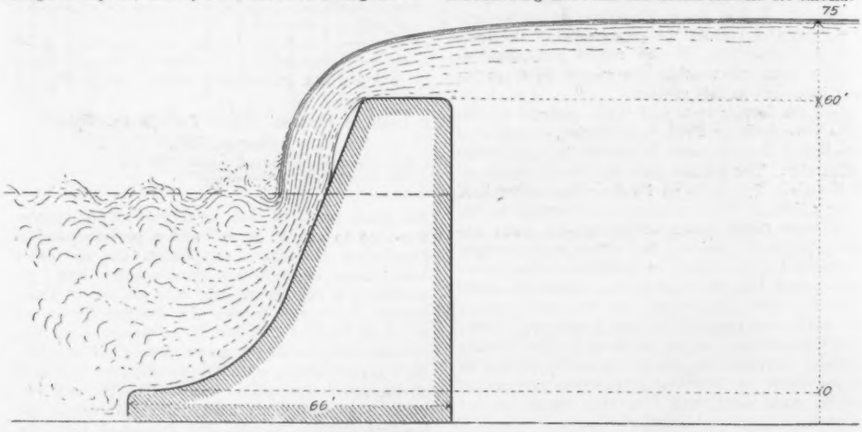
Fortunately the structures are very few which are so located as to be in danger from the causes described; and when one is so located, protection is easy and inexpensive.

LETTERS TO THE EDITOR.

WHAT IS THE AMERICAN SOCIETY OF CIVIL ENGINEERS GOING TO DO ABOUT IT?

Sir: By the accident of the Nominating Committee having nominated Mr. John T. Fanning for Director for three years, before it knew of his action in the matter of the Austin dam, the American Society of Civil Engineers has thrust upon it the election to that office of a member whose conduct is deemed by many to have been unbecoming such membership. He has been called upon to make a defense, and it has consisted (see Eng. News., Dec. 15, 1892) of adulation of the gentlemen composing the Austin Board of Public Works, to whom he reported what is false; with more adulation of the ex-mayor, to whom, likewise, he has given advice, which was not the truth, and was misleading. He has said no word in defense of his own actions, which formed the subject under examination. These were the things to be explained, if explanation were possible. And, if impossible, Mr. Fanning should not have attempted to raise false issues. He should have credited the members of the American Society of Civil Engineers with sufficient discernment to understand that kind of tactics.

In order that all the members of the Society who see this may understand this matter, you will be good enough to reprint, side by side, the absurd diagram of water flowing over the Austin dam, taken from Mr. Fanning's report, which appeared in your paper of Sept. 29, and the diagram of the same situation which appeared in your paper of Nov. 10, 1892.



Sketch Showing Section of Austin Dam with 15 Ft. of Water Flowing Over It. (Eng. News, Nov. 10, 1892.)

An engineer may make an error in the ordinary course of his practice, such as this Fanning diagram exhibits, and it may then be pardoned; or, at all events, can then be left to constitute a matter to be settled between the engineer, and the employer who had selected him. But to use a false and misleading diagram of this sort in a report as consulting engineer, and by it to instil fear and distrust into the minds of the members of a Board of Public Works, and thus cause, practically, the dismissal of another engineer and fellow-member of the American Society of Civil Engineers (as it happens, the equal or superior of the consulting engineer, in natural abilities, in education and in practical experience); to do this, is, to say the least, a gross breach of professional ethics, which should meet with rebuke from the civil engineers of the United States, and from their society, the American Society of Civil Engineers.

At a time like this, when asked to advise on the work of another engineer, and of a fellow-member of the Society, an engineer has no right to utter anything not positively known, unless distinctly given as a matter of opinion only. At such times, a false and misleading statement, or drawing, becomes a serious matter, and a wrong done to the engineer whose work is under examination. The perpetration of such wrong should be either rebuked or punished.

In the opinion of many members of the Society, Mr. Fanning should withdraw his name from the regular ticket. If elected, by force of inertia and lack of time to convey full information to the members of the Society, he should resign. If he does neither, his trial and eventual censure for conduct unbecoming a member of the Society should promptly follow. Unless the Society act on occasion in maintaining the unsull[illegible] of it members, it will have to strike out the statement of Paragraph 3, of Art. I, of the Constitution, that one of its objects is, "the maintenance of a high professional standard among its members"; for the wrong now done Mr. Frizell could then be done any other member with impunity. Each one of us might then be the next victim of the like professional assassination, and the very idea of "a high professional standard" among the members of the American Society of Civil Engineers, could be left to perish from the earth.

Assuming the facts to be as publicly stated, we gladly sign this paper.

Thomas Doane.
M. M. Tidd.
Clemens Herschel.

Members of the American Society of Civil Engineers.

(As requested by our correspondents, we reproduce herewith the two diagrams referred to, the first of which, reproduced from an issue of Sept. 29, is stated to be the one presented as showing "the form of a 15-ft. depth flood stream passing over the crest, and the method by which it might act destructively on the dam"; and the second, reproduced from our issue of Nov. 10, shows what it is claimed must be the actual conditions in such a case. We have briefly commented on this communication in another column, and publish also a telegram received from Mr. Fanning.

SWITCH LEADS.

Sir: I desire to present to the attention of engineers the following short and convenient formula for calculating switch leads, which any track foreman can recollect and apply, namely: $d = 6n$, in which d = distance from toe of frog to heel of switch and n = number of the frog. The so-called theoretical formula, $l = 2gn$, does not take into consideration the straight rail of the frog and of the switch, and gives too long a lead except for low number frogs. To overcome this difficulty we are sometimes given 9½ times the frog number for some frogs, 9 times the frog number for others, and 8½ and yet again 8 times for others. This is puzzling to a track man and burdensome to an engineer's memory. The correct formula for a regular curve between the frog and switch is

$$d = \frac{2\,(g-a)\,n - 2f}{1 + nt},$$

in which g = gage of track in feet, a = distance between gage lines of main track and of switch rail at heel of switch, f = distance from point of switch to toe, t = tangent of angle made by switch rail with main track rail, d and n as above. This formula, of course, would be useless to an ordinary foreman. The formula first given, $d = 6n$, gives approximately the same result as the exact formula for frogs and switch rails of customary lengths and is simple enough to be used by any one.

Edwin Mitchell.

Chambersburg, Pa., Jan. 6, 1893.

* Proc. Engrs. Club of Phila., Vol. IV., p. 98.

(More worthless mathematics has been ground out about frog and switch formulas than on any other subject in engineering perhaps, the professional differences on this subject arising from the simple reason that there is no absolute "proper" lead. Why this is so is at once apparent if we consider that no law of nature forbids the lead curve from being either a compound circular curve or a parabola with equal or unequal tangents, while we may make four or five different assumptions about the movable parts of the switch, for each of which there is something to be said.

If we consider the switch rail as part of a true curve, the formula $L = 2gn = 9.42n$ is almost exactly correct for leads from either curves or tangents. The variation is only a few trifling inches either way under any practical conditions. With a 5-in. throw of a stub switch, the proper length of switch rail is 3n, and of fixed lead 6.42n. With split switches, however, which are the only kind that needs to be considered much nowadays in connection with accurate work, the movable points are rarely more than about half as long as a stub switch rail, and they may be considered approximately as tangents to a fraction of the lead curve, which extends by their own length beyond their points along the main rails. If so, the proper length of fixed lead becomes 6.42n. But with large frog numbers the angle of point rail with main line becomes too large a fraction of the whole angle to fit this view; hence the angle consumed by the fixed lead will be shorter, and hence fixed lead will be shorter. Therefore, the formula fixed lead = 6n is a very good and simple one, with the proviso that: (1) with small frog numbers (large frog angles) 6.5n will give a better lead; and (2) that no particular harm will be done by making the fixed lead 6.5n in any case.—Ed.)

THE BACK-PILING OF WATER.

Sir: I inclose an open letter. I will stand by my proposition and pay if any one wants to convince me by demonstration that the theory (in question) is true.

Minneapolis, Minn., May 17, 1892.

E. T. Abbott, C. E.

Open letter to Major Edwards, Engineer of Water Power Co., Appleton, Wis.

Dear Sir: Regarding the deductions made by you from the result of the test you conducted at Osseo in the back water suit between the Osseo and Linderman Mill properties, I wish to say: Statement of facts:

(1). Field sues Linderman for $20,000, claiming that Linderman's dam backs the water up on the wheels of his grist mill.

(2). The mills are about 7,000 ft. apart. The railway bridge across the river is about 5,000 ft. above the Linderman dam. The junction of the north and south forks of the stream is about 1,000 ft. below Field's mill; the line or point to which Linderman has the legal right to back the water is about 700 ft. below the Field mill, and the junction between the Field waste way and tail race is about 600 ft. below Field's mill.

(3). All the engineers of both the plaintiff and defendant agree that the bottom of the two Field turbines are 13½ ins. higher than the top of Linderman's dam. Taft, one of the engineers for the defendant, swore (which testimony was uncontradicted) that when Linderman was at full head that the water at the railway bridge stood 1 in. higher, at the forks of the two streams 7 ins. higher, both when the Field wheels were running and when silent. When the Field wheels were silent the water at Linderman's line was 7½ ins. higher than the Linderman dam, and at the Field wheels 8¼ ins. higher than said head, and when the Field wheels were running the water at Linderman's line was 1 ft. 4½ ins. higher than his dam, and at the Field wheels it was 1 ft. 9¼ ins. higher; the water at the forks not being affected whether the wheels at Field's were running or not.

(4). By stipulation between the parties it was agreed that the evidence should be heard and that the judge should appoint an expert hydraulic engineer and an expert miller and the question tested as to back water, both when Linderman's dam was lowered 27 ins. and when it was at full head. You were selected as the engineer.

(5). The test as conducted by you was skillfully made and with undoubted fairness to both parties. In both tests the head was maintained at about 9½ ft. on the Field wheels, and the height of the water in the Field tail race carefully noted at the wheels, at a point about one-half way between the wheels and Linderman's line and at the line. These heights were in several instances exactly the same in both tests, and to all intents and purposes the same in both tests, and the miller swore that the mill ran the same in both instances and practically ground the same amount of grain in the same time.

(6). If I understand your report and testimony, on the above statement of fact, you figured that there was ½-in. of back water on the Field wheels caused by Linderman's dam, on the theory that a dam backs the water up indefinitely, and that any obstruction in a stream of any height runs to infinity in affecting the height of the water above it. My friend Loweth, of St. Paul, adhered to the same position regarding this ethereal curve, and like yourself admitted that he had never demonstrated it nor had he ever seen any one who had, but still like you insisted it was there. I take direct issue with you both and all the other theorists who take this position, and challenge any one to demonstrate or prove its truth. The levels between these mills checked within 1-100 ft. as taken by Mr. Taft, Mr. Bussell and myself for the defendant Linderman, and as compared with the levels of the three engineers of the plaintiff the greatest difference was less than an inch.

By hook gages the height of the water at any point on this or any other stream can be determined within 1-16 in. without difficulty. I unhesitatingly pronounce this curve theory an arrant fraud, and that it has no existence in fact, and that no one ever did and no one ever can demonstrate anything or any fact tending to prove its truth. It is indisputably true that the atoms of water moving among themselves are frictionless; that water will discharge into water as freely as into the air (with the same head and by gravity alone I can prove it will discharge into water quicker than it will into the air), and that it is extremely sensitive to gravity, and that any fall will cause a current, and without a fall there can be and is in no instance any current.

Now in the name of common sense how can a lower body of water hold up a higher body of water if its atoms are frictionless?

All the engineers in the case swore to the axiom that if Linderman's dam was full and no water running over, through or under the Field dam, that it would stand 13½ ins. below the bottom of the Field wheels. Supposing these Field wheels were discharging into Lake Erie and Linderman's dam was holding the water in that lake to this height, do you pretend to say that the water would rise any in Lake Erie when the wheels discharged pints as compared with the volume of water in the lake?

It does rise in the tail race when the wheels start because the cross section and water way is not sufficient to prevent it, and permit the water to spread out indefinitely. On this curve theory the dam would back it up; I insist that this is a parallel case. Again, suppose a hook gage was placed at Linderman's line and just below a flash board was put in to such a height that the height of the water at the line was not raised; then that the bed of the stream was lowered below this flash so that the 7½-in. fall between Linderman's dam and the flash was practically perpendicular at this board. By lowering Linderman's dam could it affect the height of the water running over the flash board at the line: It must if your theory is correct, and every time a bucketful of water is taken out of the Niagara River below the Falls the height of the water above the falls is theoretically affected.

It is a beautiful theory and ought to be true, as its possibilities and ramifications are limitless when judiciously applied to a back water suit, but when measured by common sense and the absolutely demonstrated attributes of water it is not there.

I am open to conviction and am willing to pay liberally for my education if any one has confidence enough to think they can demonstrate this "mischievous theory." I pronounce the whole idea a rank fake, and will stake my professional reputation and dollars that I am right, and will agree to enter into an agreement and test on any stream at my entire expense if the theory is proved true and vice versa if it is not.

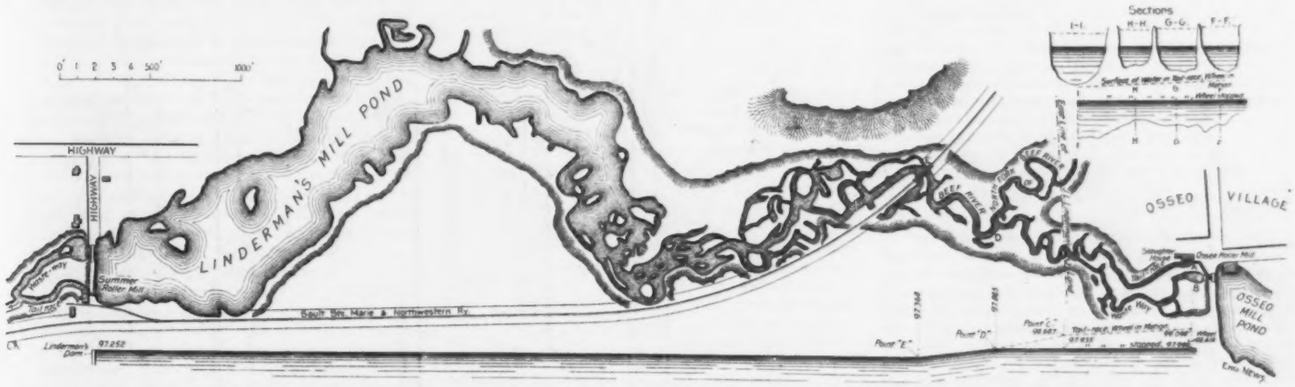
You will, of course, understand there is nothing personal in this matter, I am combating a theory advanced in this suit which I absolutely deny to be true.

Respectfully yours,

E. T. Abbott, C. E.

Minneapolis, Minn., May 10, 1892.

(We reproduce a map of the river at the locality in question.



MAP SHOWING THE LOCATION OF THE LINDERMAN AND FIELD DAMS AND ELEVATIONS OF WATER LEVELS AT VARIOUS POINTS.

In our issue of June 30, 1892, there appeared a letter of some length from Mr. Peter Hogan, C. E., of Albany, N. Y., on this general subject. Mr. Hogan cites instances where, by actual observation, it is claimed that back-piling has occurred.

In the report of the Chief of Engineers, U. S. A., for 1887-8, pp. 1305-17, there is given an elaborate study of the backwater question by Col. Wm. P. Craighill, Lieut.-Col. Wm. E. Merrill, Majs. W. R. King, A. N. Damrell and Jas. C. Post. This study is based on observations made above and below dams on the Kentucky River, and shows that ing two freshets the observed depths of backwater upon dam No. 3, caused by dam No. 2, were greater than the calculated depths obtained by using the backwater formula of Poiree, given by Debauve in his "Manuel de l'Ingenieur," vol. 19, p. 159, as follows:

$$D = H + h - ix + \frac{(ix)^2}{4H},$$

in which D is the depth at a point above a dam at a distance x from the dam.

H is the increased height caused by the dam at its site.

h is the natural height of water before the dam was built.

i is the sine of the slope.

While the above observations showed the backwater to be actually higher during freshets than the results of computations based on the above formula, it was found that during low stages of the river the calculated heights were greater than the observed heights.

It is doubtless true that a dam or other obstruc-

tion in a stream back-piles the water, owing to a retardation of the flow. But we imagine that Mr. Abbott would have considerable difficulty in proving that water will discharge as freely into water as into air. Still, we submit the facts of this case without prejudice for the consideration of engineers.—Ed.)

TRAIN RESISTANCE QUERIES.

Sir: Will you kindly inform a subscriber (1) What would be a fair value for the pull per ton on a level track necessary to start 20-ton passenger cars equipped with ordinary bearings? and (2) What is it when the speed has reached 20 miles per hour? (3) Can you refer him to any recent dynamometer tests, or to the best work on the subject of journal friction? By doing so you will greatly oblige Yours truly,

Brooklyn, N. Y., Jan. 2, 1893. H. R.

(1. Anywhere from 16 to 20 lbs. per ton to start a single car, but the resistance falls so rapidly that a less force may start a train, car by car.

2. About 4 lbs. per ton, rarely more, and never much more, at 20 miles per hour. As the speed rises to 40, 50 and 60 miles per hour, it is probable, but not absolutely proved, that the journal friction falls to 2 or 3 lbs. per ton, or even less, when all is in good order.

3. No material additions to our knowledge of railway journal friction have been made since the publication, in 1887, of Wellington's "Economic Theory of the Location of Railways," which contains perhaps the fullest summary of the information existing on that subject up to that time.—Ed.)

THE ROADMASTERS' ASSOCIATION RAIL JOINT TESTS.

Sir: Referring to the report of official tests of rail joints, in your issue of Dec. 1, p. 515, I desire particularly to call your attention to the fact that 3,818 of our truss joints, placed in track in the summer of 1889, show 99% in surface; and there is no reason why every joint should not be in surface, except that the section foreman did not use his track wrench, and turn up the rails on the truss rods. The 400 joints placed on the Chicago, Milwaukee & St. Paul in 1891 were defective, and should not have been reported upon, as they are to be replaced. The record of those in track since 1889, establishes all the claim made for the device. Yours truly Wm. S. Brewster.

Chicago, Dec. 29, 1892.

FIRE-PROOF BUILDING CONSTRUCTION.

Sir: I read with a great deal of interest your article of Dec. 1., etc., on fire-proof construction in Chicago, especially that relating to the fire at the Athletic Club Building. I had occasion to examine the fire-proof construction of a large number of buildings in Chicago during last summer, and I must confess that the majority of them, so far as the fire-proof tiling is concerned, were of very inferior material, and the methods of attaching the tiling and workmanship simply outrageous. It is a wonder in some instances that the fire-proof tile remains in place even when there is no fire or water to destroy it. On the other hand, there were a few buildings examined in the course of construction that showed a perfection of workmanship and class of material hard to beat. Unfortunately, I failed to examine thoroughly the Athletic Club Building, but from a glance at the work and material while in the building I should have classed it with those of inferior fire-proof construction. If this be true, the fire test spoken of was in reality no test of fire-proofing tile, but an excellent test of the stability of the structural ironwork even under intense heat. The material used in fire-proofing the Germania Theater Building was warped out of shape, cracked, and of a soft, porous nature, easily broken. Many of the arches between the I-beams had from 10% to 20% of the tile broken in by the workmen walking over them before the concrete was placed on them. The partition walls were made of a material closely resembling the staff used for decorating at the World's Exposition, and were thoroughly impregnated with a woody fiber that must necessarily go to pieces under extreme heat. On the other hand, the cold storage buildings just west of the river, had good, hard regularly shaped, strong and durable fire-proof tile in floor, arches and partition walls, well laid, and every piece of iron in the building thoroughly protected.

Yours truly,

John J. Dunn, County Engineer.

Columbus, O., Jan. 6, 1893.

A two-cylinder compound mogul engine has been built for the Illinois Central R. R. by the Rogers Locomotive & Machine Works, Paterson, N. J. Driving wheels, 4 ft. 8½ ins. diameter; driving wheel base, 14 ft.; total wheel base, 21 ft. 8 ins. Weight on drivers, 107,100 lbs.; total weight, 128,500 lbs. Cylinders, 20 × 26 ins. and 29 × 26 ins.

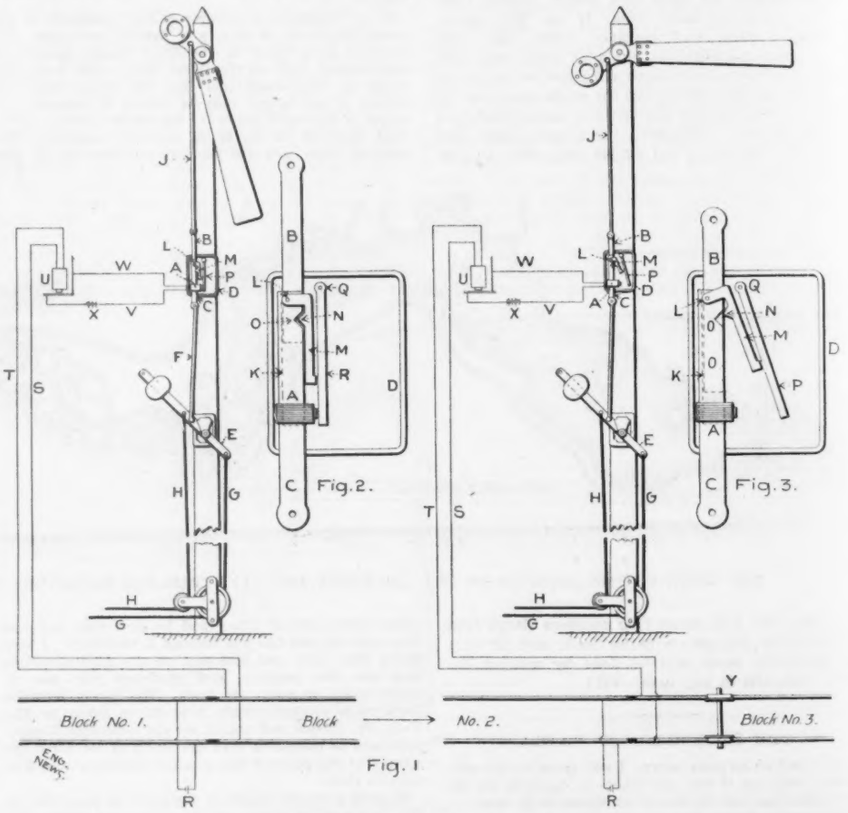
THE LATTIG MANUAL BLOCK SYSTEM.

With the increasing use of the block system for controlling the traffic on our railways, comes the introduction of new appliances to improve its practical efficiency and safety. By means of the device which we illustrate this week the presence of a train on a block section automatically retains the signal in its rear at the danger position, in spite of any attempts of the signalman to lower it and so permit another train to enter the same block section. It is, in fact, an automatic slot applied to the ordinary hand-operated system of signals, and one of its most important features for American railway service is that it can be applied to single track lines, governing the traffic in both directions. This system has been brought out by the National Switch & Signal Co., of Easton, Pa., and is the invention of Mr. J. W. Lattig, electrical engineer of the company, who was formerly connected with the Lehigh Valley R. R. as Superintendent of Telegraphs, etc.

The electric coupler or "slot" is contained in a box attached to the signal post. Fig. 2 shows the arrangement of parts within this box when the electrically controlled rod coupler is in position for coupling the rods together, as in the left hand post at Q to the inclosing box or case D, swinging against the magnet A by gravity, or away from it by the pressure of lever M, due to the downward motion of the rods J and B in returning the signal blade to its normal "danger" position.

There are two electrical circuits. The first is the track circuit, through battery R, wires S and T, and track relay U. This relay controls, through its contact points, the second circuit, which includes wires V and W, the battery X and magnet A. The arrangement of the circuits, magnets and mechanical parts is such that whenever, and so long as, the electrical circuit through magnet A is complete, the rods B and C are coupled together, and the signal can be operated. When this circuit is broken the rods are uncoupled, and although the operating lever may be reversed, the signal blade cannot be moved.

Fig. 1 shows one track of a block section, with its signals and the ends of two adjacent sections. The operation of the section above described is as follows, the traffic being in the direction of the arrow, and the signals normally at danger. When a train on block No. 1 approaches signal No. 1, the electric coupler on the signal post is in the position shown in Fig. 1, and is locked in that position by



LATTIG MANUAL BLOCK SYSTEM.

in Fig. 1 Fig. 3 shows the uncoupled position which is taken automatically as soon as a train passes a "track clear" signal, which signal then automatically returns to its normal position, indicating "danger" or "track blocked." The description of the coupling device is as follows, the letters being indicated on the cuts: The two vertical rods B and C pass through guides in the box D. The signal rod C is connected by the connecting rod F with the balance lever E, and through that with the lever in the signal tower in the ordinary way by the wires G and H. The signal rod B operates the semaphore blade by means of the rod J. The rod B slides in a slot in rod C as indicated by the dotted line K, which serves as an additional guide to keep the rods in position. At the top of rod C is a lever M, pivoted at L and provided with a lug or projection N, which engages with the notches O in the two rods B and C. These notches coincide when the signal and its operating lever are at the danger position. Another lever P is pivoted the magnet A, if there are no trains on block No. 2. The signal can therefore be lowered to "track clear" to allow the train to enter block No. 2, as shown. When the train has passed the signal, as indicated by the wheels Y on block No. 3, the circuit through the magnet A is broken, and the signal is immediately and automatically set at "track blocked" by the counterweight, the rod B then sliding down into the slot K in the rod C. The signal cannot again be restored to the "track clear" position till every wheel of the train has cleared the block section. The operator or signalman must first throw his lever to the position which would mechanically set the signal at danger (if it had not already been automatically set). This pulls down the rod C until its notch coincides with that of rod B, allowing the lug N to enter the notches, and when the train has passed off the block the circuit, through magnet A, is again complete and the rods coupled so that the signal can be lowered again. The signal is therefore automatically set

and kept at "track blocked" by a train on the block, but is lowered by manual power only.

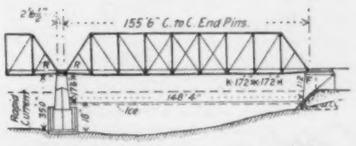
The arrangement is simple, and the details are so arranged that the signal will be set at danger in case of failure of any of the parts, batteries, rail circuits, wires, etc. A track circuit or overhead wire circuit may be used. The system can also be arranged as a simple signal slot, where two men are to control the same signal, so that even after a train has cleared the block the operator at No. 1 cannot lower the signal until the operator at No. 2 has closed his key, or "plunged." In Fig. 3 the system is shown as applied to one line of a double track, with the traffic in one direction only, but by adding an electric key at each end, with top and bottom contacts, and slightly modifying the circuits, the device makes a block system for single track with traffic in both directions, which is a very important feature in this country, where so large a proportion of the traffic is on single-track railways. It may be used for this purpose with either a track circuit or an overhead wire, but in the former case neither operator can admit by signal a second train to the block in either direction until the train already on the block has passed into the next block.

MOVEMENT OF BRIDGE PIERS BY EXPANDING AND CONTRACTING ICE.

A paper recently published in the "Transactions of the Canadian Society of Civil Engineers" gives some important facts concerning the contraction and expansion of ice on Canadian lakes and rivers, with interesting records of experience concerning the effect of this movement upon bridge piers.

The author of the paper, Mr. John H. Dumble, was Resident Engineer of the Cobourg & Peterboro Ry. in 1854, and was personally conversant with the circumstances of the destruction of a bridge on that line caused by the movement of ice. The bridge was about three miles long, crossing Rice Lake, a sheet of water some 20 miles in length at its widest part. The structure consisted of a half mile of 80-ft. wooden trusses near the center of the lake, resting on timber crib piers filled with stone, with pile trestle approaches on each side. The piles were of oak and the bents were 14 ft. apart, and caps and stringers were very heavy. The water was about 20 ft. in depth, and the bottom was of clay. A small island was crossed by the bridge about three-fourths of a mile from one shore.

This bridge was wrecked in a few minutes by an ice shove in December, 1854, a few months after its completion. The pile structure between the island and the shore was inclined at a angle of 45° toward the shore. Where it parted near the island the stringers were drawn apart nearly 7 ft., so that they fell from the corbels. Where the



Bridge Pier Moved by Expanding Ice.

thrust met the resistance of the shore it crushed the solid 12×18-in. oak stringers, and bent the iron rails double. The truss bridge north of the island was crowded toward it, so that the last span slid 4 ft. on the island abutment. The pile structure at the other end of the bridge was less affected, but was thrown badly out of line. The entire structure was only saved from total wreck by isolating it entirely from the main ice field by channels cut in the ice. Large timber cribs were built around the piers of the truss structure with inclines at the water's edge against which the ice fractured. All this damage was repaired the following season, and trains run regularly over the bridge; but the line was soon abandoned, partly on account of the trouble from ice and partly because of the completion of a parallel line.

A second instance of the destructive effect of ice, which was described at length in the discussion, is the Bay of Quinte highway bridge, at Belleville, Ont., built in 1890 by a private company for use as a toll bridge, under the direction of Mr. C. H. Keefer, M. Can. Soc. C. E. This structure consists of embankment approaches 2,800 ft. in length at one end and 800 ft. at the other, connected by steel trusses as follows: 13 spans of 98 ft., 2 spans of 148 ft., 1 span of 63 ft., and the draw span of 238 ft. The north abutment, the pivot pier and the two piers on each side of the pivot pier are on crib work foundations, the south abutment is on rock. All other piers are on pile foundations, the tops cut off below low water and inclosed by a crib filled with stone, which is sunk in the soft silt that forms the bottom of the bay and extends up to the foundation level of the masonry. The piles are from 30 to 60 ft. long, and are driven to the rock in every case. The silt and soft clay overlying the rock is 22 to 40 ft. thick, and the water is about 20 ft. deep. All the piers and abutments are built of masonry from below water line.

The erection of the steel superstructure was begun early in November, the spans being erected on a scow and floated out to position. Ice formed across the bay about Dec. 1, but the use of the scow was continued, a channel being cut for it through the ice. The weather was steadily cold with little or no snow, and by Dec. 20 the ice on the bay was perfectly glare and 10 to 12 ins. thick. On that date occurred the first ice fissure of the season. The crack started at the south shore of the bay, about 400 ft. east of the bridge, and striking the bridge about the center, where the erecting scow was frozen in, followed the line of the bridge to the north abutment. The piers were in the grasp of this enormous ice field, which in its movement exerted an immense force against them. The effect of this was to bend the piling on which the piers rested, which was not then protected by the sunken cribwork since put in place, and the piers were thrown from 2 to 12 ins. out of line. when the ice was cut away and the pressure on the piers was relieved they moved back nearly to their original position, and were brought fully back into line by the pressure of screw jacks. The movement of the piers which were founded on cribs was not nearly so great as of those founded on piles. This unlooked for occurrence gave much alarm to the directors of the bridge company, and they called Mr. Walter Shanly, M. Can. Soc. C. E., in consultation. In his report dated Jan. 2, 1891, Mr. Shanly approved of the design of the bridge, and said that the elasticity of the pile foundations had saved the piers from permanent displacement and injury. Piers of solid masonry carried down to the rock would have been far more expensive in first cost, so much so as to have made the construction of the bridge impossible, and would have been dislocated by the ice pressure some where below the water line, making repairs and restoration to line almost impossible. The building of the piers with inclined ice breakers would not have been a sure preventive unless the piers had been made extraordinarily massive. Under the circumstances, it was recommended as a safeguard against a repetition of the injury that the ice be kept cut during the winter on each side of the bridge from shore to shore, a trench some 3 ft. in width being suggested. The expense of this is very small; and while it was not expected that the bridge would pay its running expenses during the winter months, when the ice forms a free natural bridge, experience during the first winter showed that the bridge more than paid expenses, including the cost of cutting the ice.

A third case of much practical interest was described in the discussion by Mr. Duncan Macpherson, of the Canadian Pacific Ry., as follows:

The Canadian Pacific Ry. crosses the Riviere des Praries, or Black River, by means of three through truss spans of steel; two of 155.5 ft. and one of 263 ft.

The east span, shown in the diagram below, was 148.3 ft. between masonry at ice level, January, 1891:

The current is swift under the center and west spans, but comparatively slow under the east span, and in very cold seasons a solid sheet of ice forms between the east abutment and pier, but there is always open water under the other spans, and consequently no counteracting thrust due to ice expansion on the west side of pier.

The anchor bolts, 1¼ ins. diameter at the roller end of the superstructure on east pier, were found badly bent, and some of them broken; check measurements revealed the fact that the pier was slightly out of level, and the top had moved 2 ins. toward the west. The ice under the span at this time was 12 ins. thick, and the depth of water from top of ice to bed of stream at east side of caisson, 18 ft. Top of ice to top of masonry pier, 17 ft. 6 ins. A narrow channel was cut through the ice to open water, and the pier immediately came back to its normal position. This was quite apparent to the eye, by observing a fixed gage which had been run out from the abutment, on the superstructure, to the pier. This pier is built of heavy rock-faced limestone ashlar. It was built inside a timber caisson, and the bed formed by excavating a few inches of hardpan from the solid rock. The space between caisson and pier is filled in with broken stone. Height of masonry of piers, 35 ft., and length of straight side at low water line, 42 ft. It has been suggested in discussion that the pier probably cracked at the offset, near the top of the caisson, but this seems impossible, as the point of application of the ice thrust was only 3½ ft. above this offset, which would be too short a lever arm when counteracted by weight of pier and superstructure above; moreover, subsequent critical examinations with divers proved that the masonry had not been disturbed above the top of the caisson, and that the sides of the caisson and foundations were in good order. It appears more probable either that the whole pier moved slightly by tilting about its bottom edge, inside the caisson, or that the whole pier and caisson tilted together. Assuming the former, and allowing for the buoyancy of the part submerged, the total weight of pier and superstructure lifted by the ice with an arm of about 17 ft., was approximately 1,000 tons, which was not only lifted, but held up under passing trains. The top of ice is shown in the diagram by a full line, and the bottom by a dotted line, but the movement of the pier was too little to show on such a small scale.

Mr. H. Irwin, in the discussion, submitted a computation of the pressure necessary to tilt the pier. He estimated the weight of the pier and its load at 2,036,000 lbs., and supposed the ice to act on it with a lever arm of 20 ft., and to be 12 ins. thick. There being an area of 38 sq. ft. for the ice to act against, the pressure of the ice against the pier would be 102 lbs. per sq. in., or less than half the crushing strength of ice Again, with the pier tilted so as to rest on one foot in width of the caisson floor the pressure on the timber would be about 372 lbs. per sq. in.—a very moderate pressure. In reply to suggestions that the pier might have opened at the joint where it narrows from 12 ft. to 10 ft., the masonry was carefully examined by a diver, who could find no cracks. The tensile strain to cause opening at this joint would be 18 lbs. per sq. in. This pier was probably built with two to one Portland cement mortar, the tensile strength of which might be 300 lbs. per sq. in. Trautwine gives the adhesion of cement mortar at about three-fourths of the tensile strength, and I. O. Baker gives the adhesion at 60 to 80 lbs. per sq. in. It would appear from this that the joint in question probably did not open, and that the movement probably took place as suggested by Mr. Macpherson, by tilting its whole caisson.

Taking up now the physical causes which bring about the exertion of enormous pressures by fields of ice, they may be briefly explained as follows: Ice, like any other solid, changes in its dimensions with changes of temperature. When first formed, at a temperature of 32°, it has its maximum dimensions, and as it cools it contracts with enormous force. In so contracting it forms multitudes of fractures of all sizes and running in all directions. Of course these fractures only take place when the ice is contracting, under intense cold, and the water which fills the fractures at once freezes, unless the crack is a very broad one. As soon as warmer weather comes the ice expands, and these cracks being full, an enormous compression strain is set up, which is only relieved when fracture along some weak line permits the ice to shove. In shallow lakes, where very thick ice forms, the shove takes toward the shore. Ice has been forced in this way to the top of high embankments; and on the shores of many small lakes in the north a terrace has been formed by the boulders, sand and gravel, pushed back on the shore by the ice. In lakes of greater width the contraction sometimes opens broad cracks several feet across, and the expansion which follows often fractures the ice at these cracks and throws up a ridge of crushed ice sometimes two or three feet in height. This alternate contraction and expansion continues with every considerable change of temperature, beginning when the ice attains a thickness of three to five inches, sufficient for its upper surface to cool below the temperature of its lower surface in contact with the water. The movements cease when any considerable snowfall comes upon the ice, as

this serves as a non-conductor and causes the whole mass of ice to maintain approximately uniform temperature.

Experiments to determine the rate of expansion and contraction of a body of ice immersed in water under changes of temperature were made by Mr. Dumble in 1860. A rough shed was built on the ice of a mill pond at Cobourg, and a sheet of ice 103×7 ft. was isolated with an open channel 18 ins. wide all around it. The expansion and contraction of a length of 100 ft. was measured by means of a seasoned pine rod. No correction was made for the changes in length of the pine rod with changes of temperature, so what was really measured was the difference of expansion of the wood and the ice. No contraction of the ice was observed until it became 3 ins. thick, the water in which it floated keeping it probably at nearly uniform temperature. When between 3 and 5 ins. thick the ice showed movement with every change of temperature; but the range was much less than that attained at a greater thickness. The observations on ice above 5 ins. thickness showed a contraction of 0.026 ft. in 100 ft. for 32° change of temperature, which corresponds to about 16 ins. per mile.

Experiments on the expansion of ice made by Mr. T. Andrews* in 1886 between the temperatures—35° and 32° F. showed the following results:

Range.....	16° to 32°	0° to 16°	−21° to 0°	−30° to −21°
Coefficient	.000,040,876	.000,028,042	000,020,484	.000,019,744

These experiments were made on pure distilled water, frozen artificially to a cylindrical block 25 ins. diameter and 25 ins. long. Considerable difference was noticeable throughout between the rates of longitudinal and transverse expansion. The coefficient of expansion between zero and 32° corresponds to a movement of about 41 ins. per mile.

The difference between this amount and the 16 ins. per mile found by Mr. Dumble was due in some degree to the movement of the pine rod, which according to different authorities, expands from 5 to 8 ins. in a length of one mile with 32° change of temperature. The principal cause of the smaller rate of expansion observed by Mr. Dumble, however, was that the bottom and sides of the block of ice tested by him were in contact with water, and were thus kept at a constant temperature of 32°.

Really, however, the exact coefficient of expansion is not of practical importance so far as the effect on fixed structures is concerned. The important point to be noted is that the expansion of ice is a cumulative process, and that so long as a large field of ice is exposed to changing temperatures the expansion and shoving will continue. We have commented further on this subject in our editorial columns.

* Proc. Royal Society of London, Vol. 40, p. 544.

ECKLEY BRINTON COXE.

Mr. Eckley Brinton Coxe, the newly elected President of the American Society of Mechanical Engineers, was born in Philadelphia, Pa., on June 4, 1839. He was the son of Judge Charles S. Coxe, of the District Court of Philadelphia, and the grandson of Tench Coxe, prominent as a statesman, financier and author and a Commissioner of Internal Revenue during the administration of President Washington. The grandfather of Tench Coxe was Col. Daniel Coxe, who came to America in 1702, and was one of the proprietors of East New Jersey and the author of a description of the English Province of Carolina, of which his father was one of the proprietors under-conveyance from Sir Robert Heath, Attorney-General for Charles I., who had this province granted to him by royal charter in 1629.

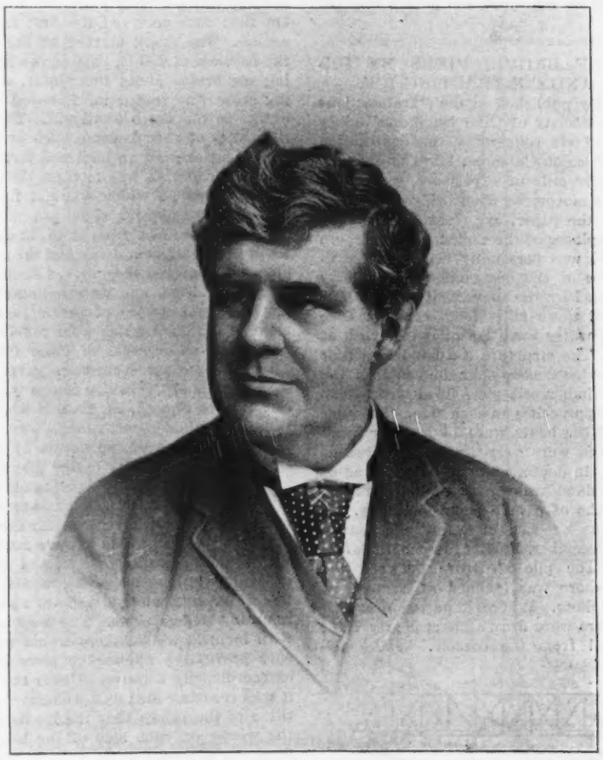
Mr. Coxe was graduated from the University of Pennsylvania in 1858, and after completing a scientific course in that institution he was engaged for some months in topographic-geological work in the anthracite coal fields of Pennsylvania. Having inherited, with his brother, large coal estates in this region, he was elected as the future manager of these properties, and in 1860 he went abroad to continue his studies in this field of engineering knowledge. Mr. Coxe spent the next two years at the Ecole des Mines in Paris and another year at the Bergakademie at Freiburg, in Saxony. Two years more were profitably passed in visiting and studying the practical operating of mines in England and on the Continent, and in 1865 he returned home and at once began active business, under the name of Coxe Bros. & Co., in the mining of anthracite coal in the Lehigh region.

In the working of these mines, in which he has ever since been engaged, he has won an enviable reputation as a practical mining engineer, for many years being personally engaged in the practice of this profession. He took an especial pride in his work as an engineer, introducing several new appliances now in common use, among these the long steel tape for more accurate underground measurements, and the plummet-lamp for more accurate sighting in mines and tunnels. The writer hereof remembers hearing, some years ago, the drafting rooms of Mr. Coxe referred to as the best equipped establishment of the kind then in the county, with enormous steel triangles and tee-squares of exceedingly fine workmanship and accuracy. In the management of his colleries he has always adopted the highest class of machinery. He was the first to lessen the risk from fire by building his "breakers" of iron and steel, and he has described "The Iron Breaker at Drifton" in a voluminous and complete paper published in the "Transactions of Mining Engineers," vol. XIX., which is in itself probably one of the most thorough treatises in existence on the preparation of anthracite coal for the market.

Mr. Coxe has always made his home at Drifton, Luzerne Co., Pa., among his miners and workingmen, and by interesting himself in the needs and laudable ambitions of his people he has succeeded to an eminent degree in maintaining that cordial relation and respect that is only too rare between the employer and the employed in large operations requiring the services of thousands of men.

Though for years the executive head of large business enterprises, Mr. Coxe has made his influence felt in many other directions. From 1881 to 1884 he was a member of the Senate of the State of Pennsylvania, where his intimate acquaintance with large industrial interests, his practical business knowledge and unquestioned integrity and honesty of purpose, made him a model legislator. Since his retirement from the Senate he has refused all offers of public office of a similar kind, but in other directions he has been active. He has been a director of the Philadelphia & Reading Railroad Co., and is now President of the Delaware, Susquehanna & Schuylkill Railroad Co., a road built by his company to connect its mines with the several anthracite carrying railways.

In 1889 he was Vice-President of the Mining Congress held at the Paris Exposition of that year, and he is a member of the American Society of Civil Engineers, the Engineers Club of Philadelphia, the President of the American Society of Mechanical Engineers, and, in 1887, was one of the vice-presidents of the American Association for the Advancement of Science. Mr. Coxe has taken a direct and marked interest in the education of youth in mining communities, and in 1879 he established an industrial school for young miners at Drifton, and placed it in charge of Mr. Oswald Heinrich, an able mining engineer, who successfully conducted it until his death, in 1883. He has written quite extensively upon this subject of technical education, explaining the theory upon which his school was founded and his ideas on industrial training. As an engineer he has contributed valuable papers to the transactions of the American Society of Mechanical and the American Society of Civil Engineers, and in 1872 he published a translation of Weisbach's "Mechanics of Engineering and Construction of Machines."



Eckley B. Coxe

PRESIDENT OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

CONTINUOUS RAILS FOR RAILWAYS.

The expansion of continuous rails, and the necessity, or otherwise, of providing space between the ends of rails to allow for expansion, was the subject of a paper read by Mr. A. J. Moxham before the convention of the American Steel Railway Association in October; and this paper, with an editorial discussion of the subject, was published in our issue of Oct. 27. Mr. Moxham gathered from the results of his experiments that rails bedded in the roadbed, as in the case of street railways, can well be butted together, or even made into continuous rails by welding or other means, but stated that a track so laid would be like a huge spring under compression, ready to move violently if, while in this condition, the roadbed should be removed. He thought that for practical purposes the length of continuous rails should be limited to 500 or 1,000 ft., with expansion joints at these intervals, and that by the elimination of the ordinary joints the weight of rail might be reduced from 100 lbs., as now used for girder rails, to 66 lbs. per yd. In his paper Mr. Moxham referred to Mr. Philip Noonan's practical test of a continuous rail track on the Lynchburg & Durham R. R., in Virginia, and we give below a description of this track, being a reprint of an article on "Continuous Rails for Railways," by Mr. T. Taylor Gleaves, in the Proceedings of the Engineers' Club of Philadelphia, April, 1891. The paper was read Nov. 15, 1890.

In 1886, Philip Noonan, a section master on a Louisiana railway, took out a patent on a "self-surfacing track," the chief feature of which is a continuous rail. Owing to the lack of means and influence, he was unable to thoroughly test the patent until June, 1889, when I laid three miles of track under that system on the Lynchburg & Durham R. R., and now, after a test of 17 months I venture this account of it.

The ground covered by the patent may be briefly stated as follows: Continuous rails of the ordinary T pattern, carried upon ordinary ties of wood or iron weighted down with a covering of earth, gravel or stone, so that they cannot easily move.

The spikes are not driven home by ⅜ in., so that undulations may take place in the rail without disturbing either the spikes or ties. At fixed points in the track, such as frogs, and at the foot of heavy grades, the main line rails are turned out with an ordinary split switch point, as if a regular turnout was to be put in.

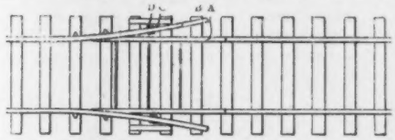


Fig. 1. Switch Point for Expansion of Noonan's Continuous Rail Track; Lynchburg & Durham Ry.

In Fig. 1, A is the switch point that continues the gage of main line; B is the main line rail turned out; C is a cast steel clutch, one end of which grips the base of the rail, the other bears against the 10-ton spiral spring D. The action of the track is as follows: Owing to the spikes being slightly lifted, the rail has a limited vertical motion, and, owing to the turnouts at each end of long sections, a free longitudinal motion. Now, when a rolling load comes upon it, minute

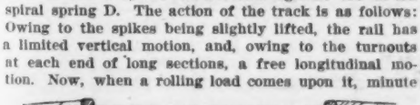


Fig. 2. Cross Section of Noonan's Arrangement of Track with Continuous Rails.

waves are formed, and the rail creeps in the direction the load is moving. You are all familiar with the annoying results brought about by this in the ordinary track, but under the Noonan system it becomes the summum bonum and brings out the striking features of the patent. The action of the track under a moving load resembles that of a linen collar when a laundryman passes a flat-iron over it; the undulations formed in front of the iron (or load) are pushed ahead to the end of the collar (or track section), leaving all behind it straight and smooth; and in the case of the rail the clutch C allows the waves to pass out, and the spring D takes up any backward motion of the rail and prevents noise or jar. Fig. 2 is a section of the track, showing the lifted spikes and the covering of the ties. In putting down the track, the first difficulty encountered was to secure an absolutely contiuous rail. The cost of electric welding placed it beyond my reach, and I was therefore forced to use two heavy fish-bars, ⅝ in. thick, bored with round holes that correspond to the fishing of the rails when the ends were brought in contact; then with drift-pins and four 1-in. rivets I made a joint that has not opened in the slightest, and a rail that is practically continuous. While the riveting was in progress, and before the track had been either surfaced, lined or covered, there was some trouble from expansion; but since it has been completed there has not been the slightest buckling, nor is there any perceptible pulling in on the curves.

The ties are covered with a red clay containing some loam, and to prevent dust I turfed a part of the track and sowed grass seed over the remainder. Now, instead of a wrench, the watchman pushes a mower, and the roadbed looks like a pretty green lawn with two metal ribbons laid across it. It is useless to call your attention to the expansion of an ordinary 30-ft. rail under the various ranges of temperature, but I am much puzzled to tell what becomes of the expansion and contraction in a rail three miles long when it is at rest. So long as rolling loads are passing over it, and the rail has a longitudinal motion given it every few hours, I can easily account for the disposition of changes in length; but these rails have remained undisturbed for 36 consecutive hours during a variation in temperature of 30°, yet the alinement of the long tangents has not varied, nor have the curves altered their position. I am well aware of prejudice against new appliances, and I, myself, confess to a conservatism that makes me dread the advent of a man with a patent. In the case of this track system I declined positively to test it until directed to do so by the president; but now that the test is made, I am a convert, and, with the zeal common to recruits, must speak out.

Quite a number of trackmen and a few engineers have examined the system. The trackmen are all delighted with it; the engineers look wise, shake their heads, and doubt its utility. One prominent manager listened very intently to a description of it and then said: "Why, it's impossible. No track can be maintained without stone ballast and constant labor."

It is natural that I should not like being doubted, yet my convictions force me to the following assertions: That there is in Virginia a section of track laid with rails three miles long; that it has been in service since June, 1889; that it has not been surfaced or lined since put down; that the only expense of maintaining it has been the watchman; that engines weighing 104,000 lbs. are frequently run over it at a speed of 50 miles per hour; that it is simply ballasted with earth, and that I shall take pleasure in showing it to any one who cares to investigate.

We are indebted to Mr. John C. Trautwine for the following extract of a letter from Mr. Gleaves, giving fuller and more recent particulars of this interesting experiment in trackwork.

You are right in your surmise as to the main line rails sliding past the switch point, and thus dividing the track up into shorter lengths, which lengths are governed either by the abrupt changes of the grade or the frog points on the regular main line. In the case that I described the rails are three miles long and the turnouts are caused by the frogs for the station sidings. My experience with the general run of railways is that the grades are rarely so abrupt as to afford many obstacles, and therefore it will be the frogs that chiefly require the turnouts.

I would not depend on a small covering of earth alone to hold the ties in place, but that taken with the fact that the ties are thoroughly bedded and that the rail has a free vertical motion the ties remain fixed. The sensation to one riding on an engine over the track is as though the track were very smooth and had under it a very heavy rail and a very heavy stone ballast. There is always some longitudinal motion, and I have seen a locomotive and three passenger coaches cause a lengthwise movement of more than 4 ins., buf there is a clutch provided to let this rail pass, and then a spring to prevent the rail jumping back. As the rails become more taut this longitudinal movement diminishes, and in the case of this track at present the motion does not exceed a small fraction of an inch.

You are mistaken in your supposition that the expansion is taken up vertically. The passing load forms waves that travel in front of it to the turnouts, and are then absorbed by the springs. There is not any hammer on the ties; this vertical motion runs rather in advance of the point of contact of the wheel. Then as above stated the rail is in constant tension, and the spikes permit the limited movement that takes place without disturbing the ties.

At intervals of from 100 to 200 ft., 3-in. terra cotta pipes are inserted. These pipes have a slot in the end that takes the base of the rail, and water falling on the track follows the rail to one of these pipes through the slot and on out into the side ditches. It is true that the earth covering is rather crude, and in my opinion the proper way is to treat the invention with an eye to permanent way; in other words use very heavy stone ballast, good iron or steel ties and a heavy rail, covering the sleepers, and, say, half the web of the rail with coarse gravel or finely broken stone. The drain pipe referred to is shown in Fig. 3. The clutch is of cast steel and shown in Fig. 4. The rail moves in the direction of the arrow, and the slot in clutch allows it to pass freely, but when it returns (clutch being set at angle shown) the sharp edges of clutch bite into base of rail, and backward motion is absorbed by compression in the spiral spring. The entire arrangement is to prevent sudden movements in the rail when it is in tension by the constant "creep" given it by rolling loads. It can all be removed without material detriment to the track, but practice shows that it at least prevents noise, and therefore I used it.

In discussion of this subject we give the following letter from Mr. E. J. Patterson, of Titusville, Pa., who, it will be seen, thinks that continuous rails are quite practicable on ordinary track. Mr. Patterson is the inventor of the rail joint illustrated in our issue of Feb. 21, 1891, and is also the inventor of a system of rolling rails with notched or wavy edges to the base, so that the spikes will prevent creeping, as noted in his letter:

Fig. 3 Drain for Track with Continuous Rails.

I am much interested in Mr. Moxham's paper in Engineering News, Oct. 27, and in the editorial comments thereon. I dissent from his theory, but indorse his results. I have long been heretical as to making provision for expansion of steel rails, and for the past four years I and doubting steel-working friends have had under examination a section, 36 rails in length, 1,080 ft., in a steam railway standard track, with 80 lb. rail and heavy angle bars. It is a double track, light up grade, lightly curved line, and full ballasted with gravel; 75% of the rails were "butted" when notes of its condition were first made. Examinations and comparisons made at different times since, with mercury in the air varying from 6° below to 96° F. above zero in the shade, show immaterial variations in the relative position of the rails, and none are visible to the eye in the surface or alinement of the track. In this and many other observed instances, this effect is certainly not due to ballast friction. I no not know the climatic conditions under which the rails were first laid, but I suspect that in these instances, as in Mr. Moxham's experiment, the results are due to the fact that a steel rail is a mass of granulations, somewhat elongated in form during the rolling process. Then, if longitudinal expansion is unrestrained, upon their absorption of heat they are relieved by elongation, but if longitudinal motion is restrained relief is obtained by lateral increase of dimension alone. I have believed this theory demonstrable, and have often discussed methods with mill men, but so far have never met the needed facilities, but I hope to do so eventually.

Fig. 4. Expansion Clutch for End of Length of Continuous Rail.

It has been an interesting experience to me to note the gradual decrease in the angle bar provision for rail expansion. Blue prints that five years since called for ⅝-in. open space now call for 3-16-in., and I have been shown one of 2-16-in. But within the same period I have seen on a first-class railway new steel laid ⅝-ins. apart, with the mercury in the air at 95° F. in the shade. It was a case of blind adherence to a mistaken conception of technical teaching, with the ever-present dread of rail spreading; but with a fairly wide acquaintance among track men I never met one who knew of a case of well maintained, summer laid, track "spreading" to a dangerous degree. Rails tip over sometimes, due I think to unsafe depth and bad proportions of rail sections, but the report thereon is usually "rails spread."

My own problem has been, how to provide for the laying of rails while exposed (as is usually the case), to an air temperature of 100° to 125° F. correspondingly elongated and therefore laid without open spaces. During the hot exposure, the rail service is perfect, but a marked cool night changes their relative positions. In the following winter with a temperature lower, in some localities, by 150° or 160° than when the rails were laid, the granulations must contract as they lose heat; and as their expansion was largely that of elongation, the contraction must be its reduction. Then the spaces develop, and "huddling" of the rails follows in places, until in other places the opening of the spaces is restrained only by the allowance of the angle-bar bolt holes. To keep a rail where it was laid as well as to permanently relieve the longitudinal strain on joints and joint ties, I have known no better expedient than to roll notches in the flange of the rail, into which the spikes of intermediate ties may be set.

If the time ever comes, as it is hoped it may, when the joint problem will be solved by the continuous rail, my theory and expedient will be laid away without regret, but I am inflicting this long letter upon you principally as a suggestion to you that Mr. Moxham's solution of the phenomenal results of his experiment is not the probable one.

PIPING WAUKESHA WATER TO CHICAGO.

In our issue of March 19, 1892, was described the proposed system for supplying Chicago and the World's Columbian Exposition with mineral water from the famous springs at Waukesha, Wis., and we have since noticed from time to time the controversy between the company which undertook the enterprise and the town of Waukesha. A general summary, showing the present status of affairs, may be of interest.

The company which undertook the piping of Waukesha water to Chicago was the "Waukesha Hygeia Mineral Springs Co.," which has for some years been doing a thriving business in bottling the water from the Hygeia spring and shipping it in bottles, cases and tank cars. Chicago, by virtue of its generally distrusted water supply, has been the chief market; and not only the Hygeia but a dozen or more other companies have reaped a rich harvest during the past few years by selling Chicagoans pure water at a few cents per gallon. At present the Hygeia Co.'s sales of water reach 5,000 to 6,000 gallons daily. By the pipe line it is proposed to bring 60,000 gallons daily to the city; and by pumping and thus increasing the head on the line, the quantity could be greatly increased. The flow from the Hygeia spring is said to be over 500,000 gallons daily, and by reducing the selling price of the water it was expected to greatly increase its consumption in Chicago. The Hygeia Co. also made a contract with the World's Columbian Exposition by which the water is to be piped to every exhibitor on the grounds, and to over 200 booths specially devoted to the sale of the water. This supply will be cooled by a refrigerating plant to a temperature of 35° at the entrance of the pipe line to the grounds. The water will be sold at a cent a glass, or 16 cents per gallon, and the company will pay to the exposition management 7½ cts. per gallon sold. Exhibitors will take their supply through meters, and can afford to pay a good price, since the artificial cooling of the water will relieve them of any expense for ice.

When the pipe line scheme was first heard of in Waukesha, we believe it was looked upon with favor; but this was succeeded by a most determined opposition by the citizens of that town. It is urged that when any one can get Waukesha water in Chicago the prosperity of the town as a health resort will begin to wane. The pipe line would cause the closing of some or all of the bottling works, and the falling off in visitors would cut off the income of many Waukesha citizens. It was further claimed that the water would suffer in quality by transit through iron pipe, and it was even charged that it was the intention of the Hygeia Co. to palm off ordinary water on its patrons, all to the injury of the pure Waukesha's reputation. Again, it was urged that the drain on the Hygeia spring would cut off the supply of other springs owned by rivals of the Hygeia Co.

As the result of some or all of these and numerout other alleged reasons, the franchise originally granted to the Hygeia Co. by Waukesha was repealed before it had been published the required number of times to make it legally binding. The attempt of the company to lay pipe from the springs to the limit of the village was resisted, first in the courts and afterward, when a force of 300 pipelayers was brought into Waukesha late one Saturday night last May, by the united valor of its male inhabitants. A pitched battle was only averted by the immediate withdrawal of the pipelayers.

Since that time the Hygeia Co. has confined its fighting to the courts, and has met with continual defeat. On Nov. 18 the Supreme Court of Wisconsin approved the decision of the lower courts that the village of Waukesha had the right to proceed by injunction against any one attempting or threatening to dig a ditch in its streets, and that the reconsideration of the grant of the franchise, prior to its taking effect, was valid.

Notwithstanding the uncertainty at the Waukesha end of the line, the company has gone on with its enterprise, and has already laid the bulk of its 104-mile pipe line, which is of riveted iron pipe, 8 ins. in diameter, protected from corrosion by asphalt varnish. We believe the distribution system at the World's Fair grounds is also practically completed.

To meet the Supreme Court decision a new company has been organized in Wisconsin, and will seek a charter from the legislature enabling it to pipe Waukesha water to any part of the state. The Waukesha authorities answered this on Dec. 19 by a published warning to all cities and towns to make no contracts with the company; and they will fight the proposed charter in the legislature.

The Hygeia Co. has also met with another obstacle in carrying out part of its scheme. The original ordinances passed by the Chicago City Council granted it the right of way for its proposed pipe line through designated streets and avenues to the World's Fair grounds. The company recently asked an amendment permitting it to lay pipes in any part of Chicago. It was at once seen that this would practically establish a competitor to the municipal water-works and the ordinance was not granted.

It seems altogether probable, however, that the difficulty at the supply end of the line will eventually be adjusted satisfactorily. If we are correctly informed, there are a considerable number of springs outside the limit of Waukesha whose purity is quite equal to that of the Waukesha and extensively advertised waters. The threat to give fame to some of these rival waters, if permission is still withheld to draw from the Waukesha fountains, will probably cause the citizens of that belligerent village to see things in a new light.

PRICES OF PIG IRON AND OF STEEL BILLETS IN 1892.

We reproduce from the "Iron Age" the accompanying diagram showing the fluctuation in wholesale market prices of three grades of pig iron and of steel billets during 1892. It is apparent that the general tendency of prices has been downward all through the year. The lowest points reached mark the minimum prices ever recorded in the American iron and steel trade. The steadiness of the pig iron prices is in marked contrast with the sharp fluctuations in the prices of steel billets, where the number of producers is so small that the stoppage of one or two mills is immediately felt in the market. If combinations among producers do not cause artificial rise in price, the tendency of steel prices is bound to be downward. The steady fall in prices of Bessemer pig is proof positive of this. The diagram shows an average difference in price between Bessemer pig and steel billets of some $9 per ton; and this is certainly a large enough margin to leave an attractive profit to steel manufacturers. In the same connection, it is of interest to note that the average difference in price between Bessemer pig and steel rails during the year has been over $15. Remembering that the great steel plants which operate their own blast furnaces can produce Bessemer pig at a cost considerably below its price in the open market, one can form an idea of the profits which are being made by the half-dozen great steel making companies which control the rail market.

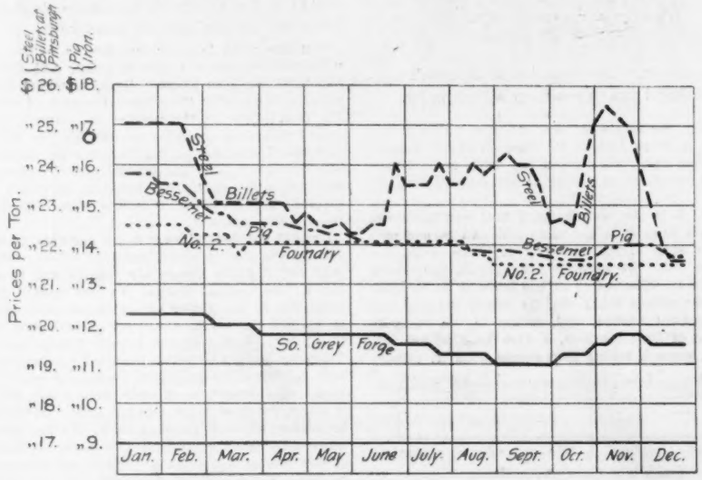


DIAGRAM SHOWING RANGE OF PRICES OF PIG IRON AND STEEL BILLETS IN 1892.

THE OUTLOOK FOR NATURAL GAS PRODUCTION.

The outlook for natural gas production is stated by "Light, Heat and Power" to be rather discouraging everywhere save in the Indiana field. The Ohio wells seem to be approaching absolute exhaustion. From nearly all of northwestern Ohio rapid diminution in the supply is reported, and the time seems at hand when the consumption will be restricted to residences, and the manufacturers will return to coal or will use fuel gas. Even with this restricted consumption, the gas will tend eventually to be used only for cooking and for open fires, as its price steadily increases.

"It is an ill wind which blows no man good," and the rapid exhaustion of the Ohio wells is bringing business to builders of gas pumps, which are used to force the gas through the mains and distributing pipes as the pressure from the wells becomes insufficient.

Pittsburg is maintaining its supply only by the constant development of new fields, a process which has to go on with great rapidity to keep pace with the consumption. At present about 25,000 families in Pittsburg and Allegheny are using natural gas, an increase of some 4,000 during the year, and the supply is being drawn from about 400 wells, of which 220 are owned by the Philadelphia Co. The large manufacturers have been generally cut off from the supply; but some of them have met this by purchasing their own wells and laying pipes to their works. The Carnegie Steel Co. alone secured the bulk of the West Elizabeth gas field as soon as it was discovered. Nevertheless, the use of gas will be discontinued at the company's Upper and Lower Union Mills as soon as the changes in the plant can be made. The suit between the Carnegie Co. and the Philadelphia Co., noted in our issue of June 16, 1892, has been settled, the latter company paying some $75,000 to $100,000 indemnity to the Carnegie Co. as indemnity for its failure to supply it with gas. The long distance to which gas is now piped necessitates a selling price which would have been deemed exorbitant in the early days of natural gas utilization. The product of the Belle Vernon field, for example, is brought to the city through a 33-in. main, 25 miles long.

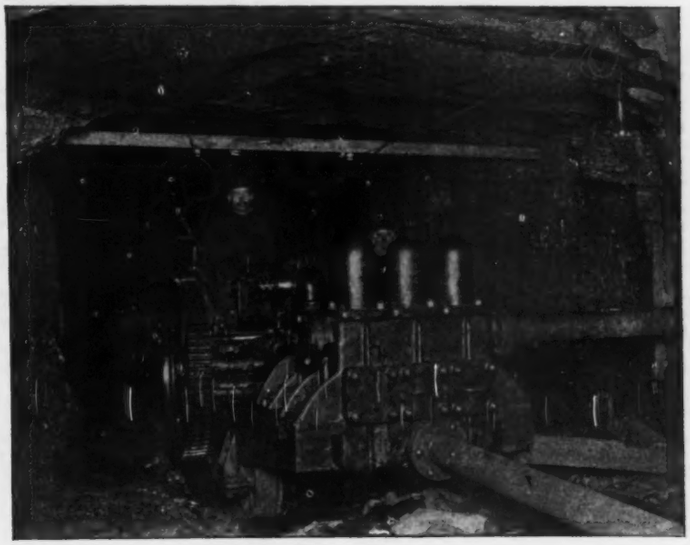
The Indiana gas field alone gives evidence of extent and staying qualities sufficient to justify faith in its large production for several years to come. Some of the latest wells struck there are said to exceed in volume and pressure any which have yet been found in the state. The piping of

gas to Chicago will undoubtedly cause a steady increase in the consumption; but at present single manufacturers in Indiana are said to be using more gas than the total amount piped to Chicago.

ELECTRIC POWER FOR MINES.

An example of the manner in which electricity is being applied in the mining industry is given by the recent installation for pumping and lighting in the William H. colliery of the Connell Coal Co., at Duryea, Pa. This colliery has an average daily output of about 1,200 tons, and improvements have been made in the plant which will enable the mine to turn out from 1,400 to 1,500 tons per day.

The electric pump is the first introduced in the mines of that section. It is of the horizontal, triplex, or three-plunger style, with 6½-in. plungers and 8-in. stroke. It makes 42 revs. per minute, and, in its present location, throws a steady stream of water through a 4-in. pipe a distance of 500 ft. from the lower workings to the main pump. The capacity of the pump is 500 gallons per minute, and its entire weight, inclusive of the motor, is 6,600 lbs. The electric motor is of 7½ HP., of the General Electric Co.'s make, and the generator, located in the main engine house on the surface, is



ELECTRIC PUMP IN COAL MINE.

of 10 HP. The power is transmitted to the motor by copper wires running down the air shaft and along the roof of the mine for a distance of 1,700 ft. The pump and motor are mounted upon a wheeled truck, and can be transported to any part of the workings. By the use of the electric pump a danger in this mine has been obviated. The steam from the steam pump formerly used is said to have penetrated the roof of the mine in its vicinity, loosening the rock and rendering it liable to fall.

Besides furnishing power for the pump, the electric generator on the surface supplies current to the incandescent lamps, which light the engine houses, the head of the shaft, the inside pumphouse, and the workings about the foot of the main shaft. It is stated that if after a few months' trial of the new system of lighting and pumping it is pronounced successful; the colliery company intends still further to utilize electricity in the mine, and to use it to operate drills and locomotives.

ICE-MAKING PLANT.

The manufacture of ice is a modern industry of growing importance, and if cooling plants also are considered is already an immense interest. Perhaps the day is not far away when the storing of natural ice will be the rare exception. As an example of the arrangement of such works, the following description of a plant at Brooklyn, N. Y., will be of interest. The plant has a capacity of 60 to 90 tons of ice per day, and was erected by the Frick Co., of Waynesboro, Pa.:

The building is divided into four parts. The first contains two 100-HP. boilers and fixtures. The second, a three-story section, contains the water distilling apparatus and the ammonia condenser. In the third and main section are the 150-ton Eclipse refrigerating machine and two iron freezing tanks, each 45×36×4 ft. Each tank holds 480 galvanized cans, 11×22×44 ins., holding the water for a 300-lb. cake of ice. The fourth section is the ice storage house.

The Eclipse refrigerating machine has two vertical single-acting ammonia compressing cylinders, 20×36 ins., and a horizontal steam cylinder, 32×36 ins., with Corliss style valve gear. This machine, at 40 revs. per minute, handles sufficient ammonia to freeze 60 tons of ice in 24 hours. In the distilling apparatus the exhaust steam from the engine or live steam from the boiler is conducted into a large separator filled with coke., over the outside of which water is constantly flowing. Here the steam is condensed, and any oil in it separated. From here the condensed water passes into a boiling tank, where it is boiled vigorously, throwing off lime, air, gases, and other light impurities. The boiling water then passes through a filter of bone black, which deodorizes and decolorizes it. Thence it passes through a cooling coil and filter of charcoal into the storage tank. When drawn from the storage tank into the freezing cans, the water passes through a filter filled with sponge as a final treatment. Thus, with proper care, almost absolutely pure water is produced.

To lift the cans of ice from the tanks, a traveling crane, driven by power, is placed over each tank. The crane lifts two cans at once and carries them to the patent pumping device, which removes the ice from the cans and slides it down a run into the storehouse.

THE REPORT OF THE BUREAU OF STEAM ENGINEERING; NAVY DEPARTMENT.

The annual report of Chief Engineer Geo. W. Melville contains less of technical interest than for some years, a fact which is explained by the partial cessation of the work of adding to the number of naval vessels. The Bureau has prepared plans, however, for the large armored cruiser provided for in last summer's appropriation bill, and is at work on the designs for the machinery of battleship No. 4. The main boilers of this vessel will be the largest ever built in this country, being 16 ft. 9 ins. in diameter and about 20 ft. long. The shells will be of steel plate 1 27-64 ins. thick. It is recommended that the "Chicago" and the "Dolphin" be provided with triple-expansion engines in place of the present compound engines. The former vessel, it is somewhat surprising to learn, has externally fired boilers with brick furnaces.

The following figures contrast the "Chicago's" machinery and that of one of the newer naval vessels:

The "Chicago's" highest speed is slightly over 15 knots, and her boilers must be replaced in any event after another cruise.

Concerning steel castings, the report says:

> I am glad to be able to report that we are now having less trouble in obtaining steel castings, showing that considerable experience has been gained and progress made in this art since we first began trying to get such work done for our new engines. That there is still considerable room for improvement in the art of making steel castings is shown by the following experience: The Bureau recently sent two designs for engine columns—one a modified form of box-girder, the other a form of I-beam—to four of the most prominent steel casting establishments in the country, asking which of the two forms was regarded as the simpler to cast. One firm reported that it could cast either without difficulty; another said that it could cast the I-beam, but that the girder was impossible; the third firm offered to make the girder but not the I-beam, saying that the latter was a form that no one could make, while the fourth establishment claimed that both forms were impossible to cast in steel.

The report gives much praise to the New York Navy Yard for the work turned out there, and it is stated that heavy marine engines and boilers can now be turned out as well and as cheaply there as by any private firm in the country. As evidence of this it is stated that the machinery and boilers for the "Raleigh" and "Cincinnati," under construction at these shops, will, from present appearances, cost considerably less than the original estimates on which the contractors refused to bid, as being too low for the amount of work required. Recently some boiler flange plates were called for and the only bid from a private firm was $81,200. A hydraulic flanging machine was bought, and the plates were flanged at the Navy Yard at a total cost of $62,781, including the total purchase price, and cost of erecting the flanging machine.

The recommendations of former years that a small appropriation be made for conducting experiments have been ignored; but the recommendation is again repeated, and if granted a portion will be devoted to experiments with liquid fuel for torpedo boats and launches.

As is quite natural, under the circumstances, a large part of the report is devoted to the personnel of the engineer force, and Mr. Melville again makes an urgent plea for its relief by a proper increase of its numbers. At present, he says, our cruising ships go to sea with such inadequate numbers of engineers as to really jeopardize the safety of the machinery and the ships.

The line and staff difficulty, concerning which so much controversy has gone on of late, is discussed at some length; and the passage of the bill now pending in Congress, which provides for the gradual increase of the engineer corps to 300 men, and confers upon its officers the authority to command in their own department is strongly urged. The following is so good that we quote it:

> The only opposition to this bill thus far has come from some of the officers of the Navy, who seem to view with jealous distrust the growing importance of the engineering branch of the service, and see in it an imaginary menace to the supremacy of the positions which they have inherited from naval conditions now obsolete. The plain fact is that the era of the sailing frigate with lofty spars and snowy canvas has forever passed away, and with the passing of the frigate must occur also the disappearance of much of the picturesque personnel which served its purpose in its own time, but which is now out of place on the sea except in its romances.
>
> Naval gentlemen who resent the intrusion of the steam engine and its attendants are doubtless sincere in their convictions, and really believe that the "Constitution" is the proper type of fighting ship and that the "New York" is not; but they draw upon the traditions of the past for their propositions and overlook the living facts of the present. The stage driver did not yield his place to the locomotive driver until a vast amount of prejudice and conservatism had been overcome by the logic of facts, and our navy will be neither modern nor efficient until it has accepted similar regulations. The sailmaker must make way for the machinist, and the boatswain for the blacksmith. The topman on a yard-arm, struggling with a weather earing in a gale of wind, is a figure that has been almost deified in the literature of the sea, but the service he rendered to his ship and his country never exceeded in importance the unsung deeds wrought daily in these times by the mechanic with hammer and chisel in the depths of an engine or boiler room.
>
> In regard to the provision of the bill which confers upon the engineer officers the rank of their grades instead of the honorary relative rank now held by them, I wish to say that the conferring of this rank would be simply an act of justice in recognizing the services of a class of officers who have to do the greater part of the work of maintaining the efficiency of our modern war vessels. This feature has been opposed by some officers who claim that it threatens

their right for absolute command. Whether or not it is good policy to intrust the full control of sailing ships, every function of which is performed by a machine, to officers who by education and training are ignorant of the operation, care and management of machinery, is a question that is worthy of very serious consideration, but it is one that is not raised by any provision of the bill which these officers oppose. On the contrary, the bill provides that the right of the engineer to exercise command shall be confined to his own department, where he does most unquestionably need that right.

The following plain statement of the reason why intelligent American mechanics will not engage in the naval service is also well put:

We do occasionally have some very excellent machinists, but they seldom serve more than one enlistment, if, indeed, they remain that long; so in practice the rating is largely made of men who, owing to some failing, can not keep a position on shore, and who are consequently unreliable on board ship. I am convinced that these men are not wholly dissatisfied with the pay they receive, nor with the works required of them, but that the whole trouble lies in the unfortunate status accorded them in the service. They are herded in with the ship's crew indiscriminately on the berth deck the same as the coal heavers; they are allowed to draw a portion only of their pay after they have earned it, there being a tradition in the Navy that a seafaring man should not be trusted with his own money; they can not go on shore except through the medium of the "liberty list," subject to the same surveillance and restrictions as govern the landsmen, and, above all these discouragements the machinist has, in common with the other men of his department, to put up with all sorts of petty persecutions from a conservative class in the Navy, not entirely confined to enlisted men, which clings to the traditions of the past and regards the entire engineer's force as a sort of pariah class, whose presence on a man-of-war is an unholy intrusion, which must be resented in every possible way. If a machinist or fireman crawls out of the hellhole where he is on duty, to get a breath of fresh air, he may be promptly driven below again, or even punished for appearing on deck "out of uniform," while the discovery of a speck of dirt anywhere on deck subjects any member of the engineer's force who may have the rashness to be above the fire-room gratings to abuse from the boatswain's mates, and probable punishment at the mast. That the decks of a man-of-war should be of spotless purity is a tradition handed down from the days of wooden ships and barefooted crews, and is so impossible a condition in these days of coal and iron and steel, that it seems a little intelligent consideration would lead to its abandonment.

It is sincerely to be hoped that the strong argument made by Chief Melville may have its effect, and result in the removal of a portion, at least, of the present absurd and antiquated rules in force in our navy. The court-martial of Assistant Engineer Danforth, discussed in our issue of Dec. 1, has brought what certainly appear to be the inadmissible claims of the line into greater prominency than ever; and, as we then said, some change from the present condition of affairs is inevitable.

The cost of a 16-in. vitrified pipe outlet sewer, 7,100 ft. long, recently completed by contract at Trinidad, Colo., is given by Mr. Norval W. Wall, City Engineer, as follows: The total cost was $11,263. The price per lineal foot was $1.48, not including extras. The contract price for masonry was $5 per cu. yd; for solid rock excavation, "extra from earth excavation," $2.50 per yd.; for nine manholes, $35 each; for 12 inspection pipes, $8 each; for lumber, 2 cts. per ft., B. M. The average cut was 6.4 ft.

A siphon of 16-in cast iron pipe, about 115 ft. long, was laid beneath the Las Animas River, in a shallow trench, for $605. The pipe was ¾ in. thick, with ordinary lead joints. At each end of the siphon there was a Trinidad sandstone manhole, laid up in Portland cement mortar, 4 ft. square, one 12½ and the other 10½ ft. deep, with concrete foundations and bottoms. These manholes cost $507. The cost of the siphon and manholes is not included in the total for the outlet sewer.

The Trans-Caspian railway, extending 900 miles, from the Caspian Sea to Samar-Kand, was opened in May, 1889. Since then the export of Russian goods to the East has increased 110%, and in 1892 202,408 passengers were carried, besides 40,000 soldiers. The principal imports into Russia are cotton, grain, wool, raisins and Indian tea.

A 48-in. cast iron water-works intake was recently laid beneath Lake Sebago, by the Portland (Me.) Water Co. The pipe was put together on the shore, with heavily leaded joints. The two ends of the line of pipe were stopped, and the pipe rolled over sticks into the lake, being checked at four points with wire cables and pulleys. A small tug towed the pipe for two miles to a trench which had been dredged for it in the bed of the lake. The water was quiet, but there was more tendency to lateral bending of the line than had been expected, the rigidity of the line depending upon lead joints.

At the outer end of the pipe a T joint was placed. In sinking, the outer end of the pipe reached the bottom in 15 or 18 ft. of water, while the 314 ft. nearest the shore remained at the surface, thus the outer 136 ft. bent to a curve. When the pipe was in this position, the shore end lacked about 12 ins. of making a junction, but in grounding in the trench, the pipe moved to within 4 ins. of the pipe in the gate house, and a joint was made with a sleeve. The work was done under the direction of Mr. E. C. Jordan, M. Am. Soc. C. E., to whom we are indebted for this information. Mr. Ephraim Dwyer was contractor.

Elm Street, New York, is at last to be opened and widened out, making an 80-ft. avenue parallel to Broadway, and extending from Chambers St. to the lower end of Lafayette Place. The total cost of condemnations of property is estimated at $2 962,150. This new street will relieve the travel on Broadway and afford a new approach to the Brooklyn Bridge.

The two high duty Gaskill pumping engines of 12,000,000 gallons capacity each, which are to furnish the water supply for the World's Columbian Exposition, have been tested, accepted, and final payment therefor made by the city of Chicago. These engines, as has been stated in our notes on the water supply of the Exposition, are located in the 68th St. pumping station, just outside the exposition grounds, and will take their supply from Lake Michigan, through a tunnel about two miles in length, and deliver water directly to the exposition grounds through a 36-in. main pipe, with smaller distribution pipes leading to the buildings. After the close of the exposition the engines will form a part of the pumping plant of the city.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

WILLIAMSPORT & NORTH BRANCH.—About 1,000 men are at work on the line from Nordmont to Dohm's Summit, Pa., 18½ miles, and the work is making good progress. The contractors are: E. J. Gaynor & Co., La Porte, Pa.

LANCASTER & HAMDEN.—At a recent meeting of the stockholders of this company the following officers were elected: Pres. John G. Reeves, Vice-Pres. W. B. MacCracken, Secy. Benj. F. Dunn, and Treas. Philip Rising. It is stated that an offer has been made by an "eastern syndicate" to complete the work.

TOBIQUE VALLEY.—The contractors Lawlor, Connor & Co., of St. John, N. B., have discontinued work on the extension toward Plaster Rock, N. S. About 10 miles have been completed this year.

Projects and Surveys.

DETROIT, PONTIAC & NORTHERN.—A railway company by this name has been chartered in Michigan.

PALISADES.—The rumor is again revived that the project of building a railway along the top of the Palisades will be carried out. It will connect with the North Hudson Elevated Ry., if built, and run to the upper end of Bergen Co.

ALTOONA & PHILLIPSBURG CONNECTING.—Bids will be received for constructing this Pennsylvania railway until Jan. 15. Ch. Engr. W. T. Forsythe, West Moshannon, Pa.

Southern.—Existing Roads.

DECATUR, CHESAPEAKE & NEW ORLEANS.—This road was sold Jan. 2 under decree of the Federal Court by Clerk Doak, in Nashville, Tenn. Granville P. Hawes, of New York, on behalf of the Organization Committee, bid the road in for $100,000. It is reported that work will be begun after the confirmation of the sale to put the road in running order from Shelbyville, Tenn., to Decatur, Ala.

OCONEE & WESTERN.—The contract for the 8½-mile extension into Dublin, Ga., has been let.

SOUTH FLORIDA.—Construction has been commenced on the proposed line from Inverness, to High Springs, Fla.

Projects and Surveys.

CHATTANOOGA & KNOXVILLE.—Chartered in Tennessee to build a railway from Chattanooga, Tenn., to a connection with the Marietta & North Georgia R. R. in McMinn Co., Tenn. Among the incorporators are: Franklin Harris, H. H. Webster, N. B. Lodor, J. R. Whitenan and C. M. Clark, all of Chattanooga, Tenn. It is stated that work will begin at once.

GLENDON & GULF MINING CO.—About 10 miles of this company's railway from Gulf, N. C., up Deep River have been graded. Ch. Engr., Frank D. Jones, Gulf, N. C.

Northwest.—Existing Roads.

CHICAGO & NORTHWESTERN.—Surveys are in progress for a railway from Highland to Mineral Point, Wis.

ST. LOUIS, CHICAGO & ST. PAUL.—This company announces its intention to extend its railway from Grafton to Hardin, Calhoun Co., Ill. The work will include a bridge across the Illinois River.

YANKTON, NORFOLK & SOUTHWESTERN.—Grading, which has been completed from Yankton, S. Dak., south to Osmond, Neb., 45 miles, has been discontinued for the winter.

Projects and Surveys.

GRANITE CITY & BELT LINE.—Chartered in Illinois to build a road from the Chicago, Peoria & St. Louis, and the Toledo, St. Louis & Kansas City roads, in Madison Co., to connect with the Wabash and the Chicago & Alton. The principal office is to be at Granite City. The capital stock is $100,000, and the incorporators are F. G. Niedringhaus, W. F. Niedringhaus, Frederick Niedringhaus, Thomas K. Niedringhaus and George W. Niedringhaus, all of St. Louis.

SIOUX CITY, CHICAGO & BALTIMORE.—A press dispatch from Sioux City, Ia., says: "The surveyors of the Sioux City, Chicago & Baltimore R. R. arrived today from Kirksville, Mo., having finished the preliminary survey across the state. The line has now been located southeastward about 90 miles through Ida and Carroll counties, and beyond that a number of surveys have been made but the line is not finally located through to Missouri. It is expected to cross the Burlington about Van Wert, and at Kirksville will connect with Quincy, Ill. The engineers report that the people along the line took great interest in the road and are very anxious to have it built."

Southwest.—Existing Roads.

SPRINGFIELD, YELLVILLE & WHITE RIVER.—Grading is now in progress between Winnerva and Yellville, Ark., and extensions to Harrison, Ark., and to Springfield, Mo., are projected. Ch. Engr., D. W. Pike, Kansas City, Mo.

LA PORTE, HOUSTON & NORTHERN.—The contract for grading the extension from La Porte to Clear Creek, 8 miles, has been let to J. F. Allen.

MISSOURI, KANSAS & TEXAS.—The Denison & Washita Valley R. R. Co., has secured an amendment to its charter empowering it to build a branch from Denison to Warner, Tex.

Projects and Surveys.

PORTLAND, MONTEREY & GULF.—This company has been chartered in Texas to build a railway from Portland, Tex., to Monterey, Mex. A press dispatch says: "The line will begin at Portland on the San Antonio & Aransas Pass Road. It will cross the Nueces River at Sharpsburg and reach the Texas Mexican National at Banquete. Thence it will run through Brownsville, cross the Rio Grande, and run straight to Monterey, Mexico. The road will be 265 miles in length. It is said that the incorporators have plenty of money for a consummation of the plan. Bonuses have been secured between Portland and Sharpsburg amounting to $30,000. Ten miles of road have been graded, and a large force of engineers and right-of-way men is at work clearing out the chaparral. Ties have been ordered for 30 miles of track, and Manager John Willacy is now on his way East to purchase the rails and attend to the other details."

The following are interested in the company: W. S. Dunlop, of Little Rock, Ark.; Jno. S. Little, of Greenwood; E. H. Henderson, of Searcy; Jno. Willacy, of Portland, Tex.; W. K. Carlisle, of Chicago; A. B. Hall, of Monticello, and others. This may be a reorganization of the Pan American R. R. Co.'s interests.

ST. CLAIR CO. COAL.—This company has been chartered in Illinois to build a railway from Madison to East St. Louis, Ill. Among the incorporators are: S. H. Hoffman, of St. Louis, Mo., and John B. Livingston and W. M. Martindale, of East St. Louis, Ill.

RED RIVER & OUACHITA TIMBER & R. R. CO.—Chartered in Louisiana to build a lumber road from the Red River to the Ouachita Rievr. The principal offices are at Benton, Ia.

Rocky Mt. and Pacific.—Existing Roads.

ATCHISON, TOPEKA & SANTA FE.—It is reported that this company will build a cut-off from Cajon Pass to Etiwanda, Cal., which will shorten the line from Los Angeles east via Barstow 17 miles.

DENVER & RIO GRANDE.—About 500 men are now at work on the line from Crested Butte, Colo., to Irwin, Colo. Levi & Moore are the contractors.

RIO GRANDE SOUTHERN.—It is reported that this company will soon build its rumored extension from Dolores or Mancos, Colo., down McElmo Creek, to Bluff City, Utah.

WASHINGTON.—Samuel Coulter, of Portland, Ore., is building a 4½-mile lumber road in King Co., Wash.

Projects and Surveys.

CLEAR LAKE & RUSSIAN RIVER RY. & NAV. CO.—Wm. J. Bigerstaff, Secy., Lakeport, Cal., writes us as follows: "This is a new enterprise. The object is to connect Clear Lake with the San Francisco & North Pacific R. R. by a railway 20 miles long. A subsidy of $50,000 is now being raised with fair prospects of success. When the subsidy is secured the work of surveying will begin, and contracts be let. Frank W. Gibson is President."

DENVER, MT. OLIVET & GOLDEN.—Chartered in Colorado to build a railway from Denver to Golden, Colo. The officers are: Pres., Daniel Sayer; Vice-Pres., David Lees; Secy., Chas. E. Tallmadge.

DENVER & WESTMINSTER.—Chartered in Colorado to build a railway from Denver to the Westminster University. Among the directors are: D. R. C. Brown, Arpen, Colo., and R. W. Woodbury and H. J. Mayham, of Denver, Colo.

Foreign.

MEXICAN CENTRAL.—The concession granted to this company for a branch from Guadalajara to the Pacific Coast has been reformed in the following particulars: The time for the presentation of the plans for second section of the line has been extended to July 1, 1894; for the third section to July 1, 1896. The company must name the port which will be its Pacific terminus before July 1, 1895. The time for the completion of the line has been extended to July 1, 1898. The Government will not be obliged to liquidate any of the subvention certificates before Jan. 1, 1897. The concession granted to the Central for the branch from Tula via Pachuca to Tampico or Tuxpam has also been modified as follows: A branch starting from a point on the line between Tula and Pachuca can be built to any point on the line between San Luis Potosi and Tampico; 50 kilos. of the line beyond Pachuca, must be completed by Dec. 31, 1895, and the entire line to the Gulf coast by Dec. 31, 1897. The time of free importations is extended to Dec. 31, 1898. The subvention bonds will be delivered by the Government as fast as each section of 50 kilos. is completed.

ELECTRIC RAILWAYS.

NEW BEDFORD, MASS.—The Dartmouth & Westport St. R. R. Co., has been organized to build an electric railway from New Bedford to Fall River, Mass. Chas. E. Cook, Fall River, Mass.; Jas. E. Dwight, New Bedford, Mass.

BROOKLYN, N. Y.—The Town Board of Flatlands has granted a franchise to the Kings Co. Electric Ry. Co. for a street railway.

BROOKLYN, N. Y.—The Twenty-third St. Ferry & Newtown R. R. Co. has been chartered to build an electric railway six miles long through the principal streets of the Eastern District. Incorporators: J. G. Jenkins, John J. Cooney, Peter Wyckoff.

NEW UTRECHT, N. Y.—The New York, Mapleton & Van Pelt Manor Ry. Co. has made application for a franchise to construct a horse, electric or cable railway.

CAMDEN, N. J.—The Ries Induction Transit Co. has been chartered to "manufacture, use, etc., a system of railway propulsion by dynamic induction." H. A.

Cramp, Philadelphia, Pa.; G. S. Duryee, Newark, N. J.

NEPTUNE, N. J.—Chartered, Asbury Park & Belmar St. Ry. Co.; capital stock, $75,000; incorporators, S. A. Patterson, N. E. Buchanan, Asbury Park, N. J.

WASHINGTON, D. C.—The Commissioners will return to Congress the bills to incorporate the East End Electric Ry. Co., and the Washington & Marlboro Electric Ry. Co., recommending that charters be granted these roads under the usual conditions.

FLORENCE, S. C.—The bill to incorporate the Florence St. & Suburban Ry. Co. has passed the legislature, and Jno. P. Coffin, Pres., states that the construction of the road will soon commence.

MOBILE, ALA.—The recent purchasers of the Mobile street railway have chartered as the Mobile Light & Ry. Co., and will arrange for changing the railway to an electric line. The incorporators are Jno. Wilson, J. H. Wilson, J. C. Lisle, G. C. Rogan, W. E. Gordon and Geo. E. Sage; capital stock, $500,000.

LANCASTER, O.—The street railway, at present four miles long, will be extended six miles and electricity substituted for horsepower.

NORWALK, O.—The County Commissioners have granted the Sandusky, Milan & Huron Electric Ry. Co. a franchise to construct an electric street railway on East Main St., from the east line of Norwalk city to East Norwalk. The line is to be completed by July 1, 1893.

PONTIAC, ILL.—Chartered, Pontiac St. Ry. Co.; capital stock, $100,000; incorporators, J. E. Monroe, D. M. Lyon and C. C. Strawn.

ST. PAUL, MINN.—A petition to build an electric railway on Third St. has been presented to the Board of Aldermen.

HORSE AND MOTOR RAILWAYS.

COLUMBIA, PA.—Chartered, Columbia & Washington Street Ry. Co.; capital stock, $40,000; Pres., Andrew J. Kaufman.—Columbia & Donegal Ry. Co.; capital stock, $75,000; Pres., Wm. B. Given.

MARIETTA, PA.—Chartered, Lancaster & Marietta Street Ry. Co.; capital stock, $90,000; Pres., Amos Bowman.

PHILADELPHIA, PA.—Chartered, Moyamensing & Penrose Ferry Road Street Passenger Ry. Co.; capital stock, $75,000; Pres., Wm. G. Hill.—Erie Ave. Passenger Ry. Co.; capital stock, $330,000; Pres., John A. Rigg.—West Girard Ave. Passenger Ry. Co.; capital stock, $30,000; Pres., John A. Rigg.

WILKESBARRE, PA.—Chartered, Northumberland & Allenwood St. Ry. Co.; capital stock, $108,000; Pres., Alex. Farnham.

HIGHWAYS.

MASSACHUSETTS.—The Commissioners of Essex County have ordered that the Newburyport turnpike, between Newburyport and Boston, shall be reopened as a public highway and that a wooden bridge be built across Parker River, the bridge to be completed by June 1.——The City Council of Fitchburg has instructed the Superintendent of Streets to begin the construction of a new county road to North Leominster.

NEW YORK.—The Bay Ridge Shore Driveway Commission, of Brooklyn, has engaged Frederick L. Olmsted to examine and fix the boundaries of the driveway.——The town of Flushing has been granted authority to issue bonds for $25,000, in yearly instalments of $2,500 each, for the improvement of Broadway from the village of Flushing to the town line of North Hempstead.

GEORGIA.—A road is to be built by the Chattahoochee Iron Co. from Canton to the ore beds. About three miles will be constructed at first.

IDAHO.—Idaho Co. has instructed its members of the legislature to work for an appropriation of $8,000 to build a wagon road between Reibald's and Lake City; $2,000 for surveying a wagon road from Meadows to Little Salmon River; and $2,500 for repairing a wagon road from Mount Idaho to Warm Spring.

CALIFORNIA.—The Board of Supervisors of Alameda Co. has decided to assist in the construction of a wagon road from Oakland over the Berkeley hills to Lafayette, Contra Costa Co. The total length of the road will be about 30 miles, and it is expected that citizens of Oakland will contribute $7,000 toward the construction.

BRIDGES, TUNNELS AND CANALS.

NEW YORK, N. Y.—The Long Island R. R. Co. has made an application for permission to construct a bridge across the Dutch Kill to replace the present structure. The design is for a swing bridge with a center pier and operated by an electric motor.

FLUSHING, N. Y.—The Town Board will apply for permission to bond the town for $16,000 to construct a bridge at Douglastown.

SAGINAW, MICH.—The Flint & Pierre Marquette R. R. will replace its present bridge across the Saginaw River by bridge to cost $50,000.

WATER-WORKS.

New England.

NORTHFIELD, VT.—F. H. Howe informs us that works are talked of.

ATTLEBORO, MASS.—The contract for a pump for the South Attleboro station has been awarded to the Deane Pump Co., Holyoke, and for two boilers to the Porter Manufacturing Co., Syracuse, N. Y., for $2,600.

PEPPERELL, MASS.—Town Clk. P. J. Kemp informs us that there is some talk of building works.

PROVINCETOWN, MASS.—Bids for laying about eight miles of mains are wanted until Jan. 25. Address Water Commissioners or Engr. Louis Hawes, Boston.

NEW CANAAN, CONN.—E. H. Phipps, New Haven, is interested in preliminary investigations for works here.

WINSTED, CONN.—A contract for a 4,000-ft. rock tunnel, two earth and two masonry dams, and 2,500-ft. canal has been awarded to Babcock, Leary & Co., Newburg, N. Y., for $82,765.

Middle.

BROOKLYN, N. Y.—The aldermen have authorized Comr. of Public Wks. J. P. Adams to buy three new pumping engines for the Ridgewood station, and two for the Millburn station, voting $685,000 of bonds for this purpose, and the remodeling of the two old engines at Ridgewood; they also provided $70,000 for two new engines at the Underhill Ave. station, to be used in connection with the New Prospect Hill water tower.

FORT EDWARD, N. Y.—Engr. S. E. Babcock, Little Falls, has reported on village works, recommending a gravity supply, two reservoirs, a filter chamber, an 8,160-ft. supply main of 20-in. pipe, and a distributing system; estimated cost, exclusive of land and water rights, $106,087.

FLUSHING, N. Y.—A new stand-pipe is talked of. G. A. Roullier, Supt.

MILFORD, N. Y.—Chester Gurney and C. S. Barney are on a committee to report on introducing works.

NEW YORK, N. Y.—Bonds to the amount of $250,000 have been ordered issued to begin construction of a high service system, including a 24,000,000-gallon pumping station, and a large water tower. The city has authority to issue $500,000 of bonds for the system.

NEW YORK, N. Y.—Bids for cast iron pipe, specials, hydrants and wooden boxes, stop cocks and iron stop cock boxes, are wanted by the Department of Public Works.

ROCHESTER, N. Y.—The contract for the first section of the new supply conduit, 12,000 ft. of masonry conduit, 6 to 6½ ft. high and wide, has been awarded to Wm. H. Jones & Sons, for $292,518.

YONKERS, N. Y.—Engr. J. J. R. Croes, New York, has reported that an additional storage capacity of 550,000,000 gallons is needed, which may be secured by building a short dam across an existing supply pond and building the proposed Palmer Hill reservoir, with a capacity of 333,000,000 gallons.

WARSAW, N. Y.—The Trustees are talking of buying the present or building new works.

JERSEY CITY, N. J.—The Street & Water Commissioners have rejected all the proposals for a new water supply recently received.

NEWTON, N. J.—Town Clk. John S. Kintner informs us that the water-works question is being agitated.

HARRISBURG, PA.—Cy. Clk. Chas. A. Miller, informs us that a new pumping engine is proposed.

NORTHUMBERLAND, PA.—Town Clk. J. G. Diffenbach informs us that gravity works, with 30 hydrants, are proposed, to be put in next April.

PENNSYLVANIA.—The following companies have been incorporated: Putnam Water Co., Chartiers; $1,000; Treas., W. W. Murray, Knoxville. Lebanon Water Co., Mansfield; $1,000; Treas., W. W. Murray, Knoxville, Susquehanna Water Co., Plainsville, Luzerne Co.; $2,500; Treas., Owen B. McKnight, Highland Water Co., West Newton, Westmoreland Co.; $10,000; Treas., P. W. Morgan, Irwin.

Southern.

WILSON, N. C.—Bids for works are wanted. See advertisement.

AUGUSTA, GA.—P. S. North, Clk. of Council, informs us that a stand-pipe is proposed.

VALDOSTA, GA.—Cy. Clk. M. Ashley, informs us that water and sewerage systems are projected.

WEST END, GA.—This place has petitioned Atlanta to supply water to a proposed distribution system.

GRILLE, MISS.—Cy. Clk. J. M. See informs us that works are proposed.

WATER VALLEY, MISS.—Water and electric light plants are talked of.

KNOXVILLE, TENN.—The Council has passed a resolution instructing the City Attorney to prepare an act authorizing the city to build works.

CYNTHIANA, KY.—Cy. Clk. J. S. Williams informs us that the city is planning to secure works.

North Central.

ASHLAND, O.—Cy. Clk. F. Morrow informs us that the city is making inquiries regarding the cost of works.

CLEVELAND, O.—A contract for a mechanical stoker has been awarded to the Murphy Iron Works, Detroit, Mich., for $6,083.

LEBANON, O.—Cy. Clk. R. B. Corwin informs us that the city plans to have works on the franchise plan, retaining the right to buy the works.

NAPOLEON, O.—Cy. Clk. J. Reist informs us that the city has contemplated putting in water and electric lighting plants, but has not yet come to a decision.

NELSONVILLE, O.—Cy. Clk. Eben Wilson informs us that the city expects to construct water and sewerage systems this year.

READING, O.—Bids for $40,000 5% water and electric light bonds are wanted until Feb. 7. A. G. Aukenbauer, Vil. Clk.

SANDUSKY, O.—Engr. Chas. A. Judson has recommended that a 5,000,000-gallon mechanical filter plant be established; cost, $40,000 for filters and $7,500 for buildings, connections and incidentals. Mr. Judson estimates the daily cost of operating filters at $4.50 per million gallons filtered.

WARREN, O.—The company is investigating filtration.

EDINBURG, IND.—Bids for works are asked in our advertising columns.

PETERSBURG, IND.—The Petersburg Electric Light, Power & Water-Works Co. has been incorporated; $10,000.

ROCHESTER, IND.—Engr. J. F. Witmar, of Voorhees & Witmar, Buffalo, N. Y., will make plans for works here.

BELLEVILLE, ILL.—It is stated that Supt. M. T. Stokey contemplates the erection of a storage reservoir at a level higher than the present one.

COLLINSVILLE, ILL.—A contract for works has been awarded to Chas. A. Stookey, Belleville.

MENARD, ILL.—The Chester Light, Water & Ice Co. has been incorporated; $35,000; Geo. D. Edwards, Wm. H. Bryan and John D. Geriach.

WENONA, ILL.—An attempt to secure works is being made. It is said that a supply is now furnished by the La Salle Works.

DE PERE, WIS.—Cy. Clk. T. N. Casey informs us that a pumping station will be added.

LA CROSSE, WIS.—The City Clerk informs us that the city plans to lay $25,000 of mains.

PLATTEVILLE, WIS.—Cy. Clk. A. W. Hastings informs us that there is some talk of introducing works.

Northwestern.

CENTREVILLE, IA.—Cy. Clk. J. N. Dunbar informs us that works are projected.

CHANUTE, KAN.—Cy. Clk. J. W. Buchanan informs us that works to be owned by the city are proposed.

OSAWATOMIE, KAN.—Cy. Clk. K. Mount states that works are talked of.

Southwestern.

CAPE GIRARDEAU, MO.—Cy. Register G. E. Chappell informs us that this place has just organized as a city of the third class and plans to build works.

CLAYTON, N. MEX.—The Clayton Electric Light and Water Supply Co. has been incorporated; $20,000. Works were built here in 1886 by the Union Pacific Ry. Co. This item inadvertently appeared under Clayton, Tex., last week.

Pacific.

PORTLAND, ORE.—F. T. Dodge, Clk. Water Com., informs us that contracts will probably be let in February for a 30-mile pipe line. Specifications will soon be ready.

Canada.

WINDSOR, ONT.—Engr. Willis Chipman, Toronto, has recommended a new intake pipe 8,000 ft. long and 27 ins. in diameter; estimated cost, $54,000.

ARTESIAN WELLS.

ABERDEEN, S. DAK.—Cy. Auditor Geo. Bolles informs us that the city plans to sink a well.

KANSAS CITY, TEX.—Otto Buchel & Co., Cuero, Tex., advertise that this place "has $4,000 in cash to pay for a flowing well."

IRRIGATION.

TUCSON, ARIZ.—A press dispatch from this place states that large irrigation works are to be built by Eastern capitalists in the southern par of Mohave County. A dam across Spotted Canyon, on Bill Williams Fork, is proposed, and a 3-ft. steel supply pipe from 5 to 15 miles long.

NEW COMPANIES.—Rio Mimbres Irrigation Co., Chicago; $300,000; Lucius G. Fischer, Albert G. Spalding and Frederick Ullman. Berthoud Pass Canal & Tunnel Co., Denver, Colo.; $250,000; to construct tunnel through Berthoud Pass to convey water from Frazer River for irrigation. Hilltop Reservoir Co., Longmont, Colo.; $10,000; W. R. Blore, W. S. Mitchell. Lagunitas Canal & Irrigation Co., Albuquerque, N. M.; $5,000. Grape Vine Ditch Co., Eddy, N. M.; $1,000. Luna Irrigation Co., Luna, N. M.; $5,000; constructing reservoir in Bush Valley. Rio Grande Irrigation & Homestead Co., Las Cruces, N. M.; $5,000,000; irrigating and improving land in New Mexico, Texas and Mexico.

SEWERS.

LAKEPORT, N. H.—At a special town meeting Jan. 7 the citizens voted to construct a system of sewers in district No. 13 and to issue bonds to pay for the same, subject to the action of the legislature. B. F. Drake, G. A. Ferguson and C. A. Sleeper are members of the newly appointed Sewerage Committee.

MANCHESTER, N. H.—The Mayor recommends that bonds be issued for the extension of sewers.

EVERETT, MASS.—Mayor Evans says the sewerage system has already cost about $107,000, and that it seems probable the original estimate of $180,384 for 28 miles of sewers will be exceeded by $100,000.

HOLYOKE, MASS.—It is reported that $300,000 will be spent this year in constructing sewers. A system is needed, according to Mayor Farr, in Elmwood, Oakdale and Springdale.

LYNN, MASS.—We are informed by Chas. W. Gay, Cy. Engr., that the $20,000 noted in our issue of Dec. 15 as appropriated for sewers was for the completion of work already under way. No new work of importance is being planned.

WALTHAM, MASS.—We are informed by the Board of Sewer Commissioners that all bids on the Linden St. sewer have been rejected. It being state work the Board of Trustees of the Massachusetts School for the Feeble Minded have decided to bring the subject before the next legislature for authority. The bids received ranged from $12,500 to $15,800.

FAR ROCKAWAY, N. Y.—The Sewer Board has voted in favor of the gravity system of sewerage, and the plans of T. D. Smith, Engr., and J. J. Powers, Consult. Engr., for sewage disposal. The estimated cost of constructing the proposed 14,560 ft. of sewers, gravity system, is $24,000 to $29,000. The deepest cut is 14 ft. 8 ins., and average cut 9 ft.

NEW YORK, N. Y.—The Commissioner of Public Works will receive bids until Jan. 17 for five contracts for sewers.

ROCHESTER, N. Y.—The East Side Trunk Sewer Commission will receive bids until Jan. 18 for section 6 of the trunk sewer; 6,326 lin. ft. City Surveyor McClintock has submitted plans for the drainage of the land south of the Pinnacle range, about 244 acres. Several plans were presented, estimated cost from $65,000 to $70,000, but the one recommended is for an 18-in. vitrified pipe sewer to cost $16,000. The West Side commissioners expect to advertise for bids by March, and it is thought the cost of this sewer will be about $250,000.

STAMFORD, N. Y.—The Board of Sewer Commissioners will receive bids until Feb. 1 for a sewer system and disposal works.

SYRACUSE, N. Y.—H. C. Allen, Cy. Engr., has prepared places for a 6×8 ft. stone sewer in the Harbor Brook Valley; estimated cost, $280,000.

TROY, N. Y.—The Common Council is considering the construction of about 25,000 ft. of sewers.

MONTCLAIR, N. J.—The Township Committee has contracted with C. P. Bassett and J. E. Owen to prepare plans and specifications for the proposed sewer system. The estimated cost of the system is $350,000, and it is hoped that construction may commence by March.

SCOTTDALE, PA.—We are informed by B. C. Fretts, Burgess, that contracts for about two miles of sewers will probably be awarded about March 1.

ASHTABULA, O.—We are informed by H. E. Mann, Cy. Engr., that the city will probably construct about two miles of sewers during the coming season.

CANTON, O.—The City Clerk will receive bids until Jan. 23 for machinery for sewage disposal works of 2,000,000 gallons daily capacity. See advertisement.

CLEVELAND, O.—The Board of Control has prepared plans for sewers in five streets. Director Herrick expects to begin work on the Walworth run sewer early in the spring. The sewer will be 15-ft. diameter and will empty into the river. Mr. Herrick estimates its cost at $200,000 and thinks the construction will take about two years. It will drain nearly all of the West

and South Sides and is to be built so as to connect with a main sewer under the river, if one is built.

PORTSMOUTH, O.—City Engineer Bryan has completed plans for the proposed sewer in Ward 6. It will drain 225 acres and cost about $30,000. There will be 7,830 ft. of brick sewer and 6,830 ft. of pipe.

VISALIA, CAL.—An ordinance has been prepared granting a franchise to a private corporation for the construction of a system of sewers.

TACOMA, WASH.—The City Council is considering plans for a sewer to drain about 800 acres and estimated to cost $41,700 to $44,500.

STREETS.

BOSTON, MASS.—The Common Council has requested the Finance Committee to provide $5,500 for widening Poplar St., and for paving as follows: West Newton St., with asphalt or brick, $8,000; Boylston St., asphalt or brick, $10,000; Piedmont St., block stone, $5,500.

BRADFORD, MASS.—At a special town meeting Dec. 29 the selectmen were authorized to petition the legislature for right to extend the debt limit by $25,000 for paving Main St.

BINGHAMTON, N. Y.—It is reported that Collier St. is to be paved with asphalt in the spring.

JAMESTOWN, N. Y.—The Board of Public Works has recommended the following work: 72,721 sq. yds. brick paving, estimated cost $2 per sq. yd.; 7,610 sq. yds. stone paving, $3.25 per sq. yd.; 32,436 lin. ft. stone curbing, 42 cts. per lin. ft.; 2,136 lin. ft. iron gutter, $2.30 per lin. ft. Bonds are asked for $60,000 to pay the city's share of the expense.

ORLANDO, FLA.—We are informed by J. K. Duke, Cy. Clk., that the streets are being paved with clay, which hardens and becomes practically impervious to water, when properly laid.

ASHTABULA, O.—H. E. Mann, Cy. Engr., informs us that the city will probably let contracts in March for 20,000 sq. yds. of brick pavement.

CLEVELAND, O.—The City Council has voted to pave in 52 streets this year. The total distance is 20.8 miles, and is divided as follows: Dressed block Medina sandstone, 66,268 ft.; common Medina sandstone, 24,184 ft.; brick, 11,248 ft.; asphalt, 8,512 ft. The city is planning street work to cost about $1,200,000.

DAYTON, O.—The City Council has accepted an invitation of the Trinidad Asphalt Co. to visit Cincinnati and examine the asphalt pavement of that city. A bill is being prepared for the legislature authorizing the city to issue bonds for $500,000 for paving.. Three additional streets have been ordered paved, to cost about $150,000.

ST. LOUIS, MO.—The Board of Public Improvements will receive bids until Jan. 17 for paving in four streets with Trinidad Lake asphalt. The estimated cost of the improvement of Union Boulevard is $43,023 with telford pavement, or $59,475 with asphalt.

ELECTRICAL.

SPRINGFIELD, MASS.—The City Council is taking steps in favor of a municipal electric light plant.

WOBURN, MASS.—The City Council has unanimously adopted a resolution that it is expedient for the city to establish an electric light plant.

EAST HADDAM, CONN.—The Salmon River Power Co. has been organized to develop and distribute water power and electric power; capital stock, $50,000.

BATAVIA, N. Y.—The only bid received for lighting the streets by electricity for two or five years was that of the Consolidated Gas & Electric Co., $95 per light per year for 73 arc lights to burn every night and all night.

JAMESTOWN, N. Y.—The Board of Public Works has recommended that the municipal electric light plant be extended at a cost of $15,000.

WATERPORT, N. Y.—A proposition has been made by Geo. Sprague to utilize the water power at this place for generating electricity to be transmitted to Albion and intermediate places.

WAYNESVILLE, N. C.—It is reported that W. P. Welch, Athens, Ga., contemplates erecting an electric light plant in this place.

ATLANTA, GA.—The Mayor has recommended that the city get information as to the cost of a municipal electric light plant.

ALTON, ILL.—The city is considering bids for electric lighting. Owing to a failure to come to an agreement as to price, the Alton Gas & Electric Light Co. has refused to furnish either gas or electricity to the city since Jan. 1.

ST. CHARLES, MO.—The city authorities will get estimates as to the cost of increasing the capacity of the electric light plant. It is the intention to increase the number of street lamps and to extend the commercial service.

WESTPORT, MO.—The Board of Aldermen is considering the granting of a franchise to the Kansas City Electrical Works. The ordinance provides for electric street lighting by the company.

TRINIDAD, COLO.—Norval W. Wall, Cy. Engr., sends us the following information: The Trinidad Electric Light, Heat & Power Co. has a contract with the city, which will expire in June. The Mountain City Electric Co. has been granted a franchise for 20 yrs., and the city has contracted for 40 arc lights to take the place of those now furnished. The franchise stipulates that as long as the price of slack does not exceed $1.25 per ton, the maximum rate shall be as follows: To the city, $11 per month for each 2,000 c. p. arc light up to 40 and $10 per month for each additional, and $1.25 per month for each 16 c. p. incandescent light, the lights to burn all night and every night; to individuals, $17 per month for arc lights and $1.75 for incandescents, if the lights burn all night; $15 and $1.50 if till midnight; $12.50 and $1.25, if till 10 o'clock; $11 and $1.15, if till 8 o'clock; and for private residences, 75 cts. per month for each 16 c. p. incandescent light. The company shall also furnish to the Trinidad Street Railway Co., or any other street railway in the city, sufficient power to move its cars at a maximum price of 47 cts. per HP. per day of 18 hours, or $140 per month per car, and a minimum rate of $90 per month per car. The company's plant is to be separate in every particular from the present plant.

WALLA WALLA, WASH.—The following bid was received for street lighting: Walla Walla Gas & Electric Co., $12 or $11.50 per light per month, for a contract for one or three years, respectively; the company to furnish 40 or more 2,000-c. p. arc lights to burn all night and every night. The city now has 47 arc lights at $12 each per month.

CONTRACT PRICES.

GRADING.—McKeesport, Pa.—The contract for grading about 20,000 cu. yds., or 4.5 miles, for the McKeesport & Wilmerding Street Ry., has been awarded to P. Keating & Co., Pittsburg, at 32 cts. per cu. yd.

PINE BLOCK PAVING.—Galveston, Tex.—The contract for paving about 60,000 sq. yds. with creosoted long leaf, heart yellow pine blocks has been awarded to Ricker, Lee & Co., at $2.35 or $2.55 per sq. yd. for 5-in. or 6-in. blocks, respectively, without wedges; grading, 10 cts. per sq. yd.

DREDGING AND EMBANKMENT.—Oakland, Cal.—The bids for dredging Lake Merritt and building a stone embankment as an extension of the outer wall, ranged as follows: Temporary dam of earth and stone, 30 cts. per cu. yd. for the earth to $1.50 for the stone; dredging 20,000, 40,000 or 60,000 cu. yds., 19 cts. to $1.55 per cu. yd.; stone embankment, 85 cts. to $1.60 per cu. yd.

DREDGING.—Detroit, Mich.—Gen. O. M. Poe, U. S. Engineer Office, has awarded the contracts for the 21-ft. channel between Chicago, Duluth and Buffalo, to the lowest bidders. The work on section 5 was divided equally, as the same bid was made by two firms. The firms were published in our issue of Dec. 22.

BREAKWATER EXTENSION.—Dunkirk, N. Y.—The lowest bid received for extending the breakwater 270 ft. was that of Henry K. Gustin, Ann Arbor, Mich., as follows: Hemlock timber, $21 per M. ft.; white pine, $32; drift bolts, 3½ cts. per lb.; screw bolts, 5 cts.; boat spikes, 4 cts.; foundation and filling stone, $1.25 per cu. yd.; dredging, 50 cts. per cu. yd.; total, $15,102. The price for stone is considered very low, as stone is scarce about this place.

OAK TIMBER.—Mt. Carmel, Ill.—The contract for furnishing oak timber for the construction of a dam near this place, has been awarded to Henry C. Jones, Madison, Ind., at $23 per M. ft. for white, burr or chincapin oak, and $20 for red, black or water oak.

MISCELLANEOUS.

GARBAGE DISPOSAL.—Buffalo, N. Y.—The Department of Public Works will receive bids until Jan. 21 for the sanitary destruction of the garbage of the city for a period of five years from June 19.

Dayton, O.—The City Controller will receive bids until Jan. 30 for the disposal of city garbage for a period of 15 years.

LUMBER.—Sioux City, Ia.—The City Engineer has been authorized to advertise for bids for 200,000 ft. of lumber.

TERMINAL STATION.—Brooklyn, N. Y.—The plans and specifications for the Brooklyn terminal station, between Sands and High Sts., of the Brooklyn Bridge, are now ready, and bids for the construction are advertised for. C. C. Martin, Supt.

IRON FENCE AND COPING.—Cincinnati, O.—The Board of Park Commissioners will receive bids until Jan. 16 for 980 lin. ft. of wrought iron fence, and 980 lin. ft. of Indiana flat rock fence coping, 8 × 28 ins. and 6 ft. long, at Lincoln Park.

PIER WORK AND DREDGING.—New York, N. Y.—The Department of Docks will receive bids until Jan. 19 for the removal of Pier, old, 42, and dredging about 37,200 cu. yds.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Brooks Locomotive Works, Dunkirk, N. Y., have built 18 consolidation engines for the Buffalo, Rochester & Pittsburg, 10 six-wheel switch engines for the Great Northern, and 3 eight-wheel engines for the Peoria & Pekin Union, and are building some engines for the Chicago, Rock Island & Pacific. The Schenectady Locomotive Works, Schenectady, N. Y., have an order for two engines for the Merchants' Terminal Co., of St. Louis, Mo. The Cooke Locomotive Works, Paterson, N. J., have an order for 4 passenger and 6 freight engines for the Louisville, Evansville & St. Louis. The Dunkirk Engineering Works, Dunkirk, N. Y., have built an engine for the Chautauqua Cement Co. The Rhode Island Locomotive Works, Providence, R. I., have an order for 16 two-cylinder, compound Forney tank engines (Eng. News, Dec. 27, 1890,) and Jan. 3, 1891,) for the Brooklyn & Seaside Elevated, at $6,000 each; the Brooklyn Elevated will also probably add some more of these engines, of which it now has three, to its equipment, as well as some simple engines. The Chicago, Burlington & Quincy will add about 50 engines to its equipment.

CARS.—Osgood Bradley & Sons, Worcester, Mass., have an order from the Brooklyn Elevated for 60 cars, to cost $3,500 each, for its Brooklyn & Seaside extension to Fort Hamilton. The Mount Vernon Car Co., Mount Vernon, Ill., is building 500 freight cars for the Illinois Central. The Pullman Palace Car Co., Chicago, Ill., has built a sleeping car with arched instead of monitor roof for the Chicago & Alton; and is building 40 street cars for the South Chicago Ry. Co. line and 20 for the Citizens' Street Ry. Co., Detroit, Mich. The Middletown Car Co., Middletown, Pa., is building 300 cars for the Burton Stock Car Co. The Wabash is building a number of box cars at its own shops. The Northern Pacific will build its own freight cars at the new shops at Edison, Wash., and is filling orders for lumber cars. The Buffalo, Rochester & Pittsburg has added 850 freight cars, fitted with the New York air brake, to its equipment.

Greenville Ohio, Water-Works.

Sealed proposals will be received until noon of Tuesday, January 31st, 1893, by the City Council and Board of Control for the following items for the Greenville, Ohio, Water-Works:

One thousand and forty-eight (1,048) tons of cast iron water pipe, from four (4) to fourteen (14) ins. diameter.

Forty-four thousand five hundred and eighty-six (44,586) pounds of special castings for above pipe.

One hundred and seven (107) double nozzle fire hydrants.

Seventy-four (74) stop valves and seventy-four (74) stop boxes for above pipe.

Laying of above pipe and setting of above special castings, fire hydrants, stop valves and stop boxes.

One brick pumping station and one brick chimney.

The connecting together of a system of driven wells.

Two (2) compound condensing duplex, direct acting pumping engines, each of one million five hundred thousand (1,500,000) gallons daily capacity, together with two (2) return tubular boilers, and all appurtenances necessary to complete said machinery.

One steel stand-pipe and masonry pier.

Proposals must be made on the blank forms furnished by the City Council and Board of Control of Greenville, Ohio, and all legal formalities must be complied with to secure consideration of the proposals.

The preliminary bonds and date of furnishing materials and completion of work must be filed to constitute a formal proposal.

Plans of above work may be examined and blank forms of proposal and specifications can be obtained at the office of the City Council, Greenville, Ohio, or the office of the Engineer, Rooms 35-36, Glenn Building, Cincinnati, Ohio.

The proposals must be sealed and addressed to the City Council and Board of Control, Greenville, Ohio, and be indorsed with the name of the person, firm or corporation which makes the tender.

And be accompanied with a certified check payable to the order of the City Clerk, as follows:

Water pipe and special castings	$500.00
Fire hydrants	300.00
Stop valves	200.00
Pipelaying	400,000
Pumping station, and chimney	300.00
Pumping machinery	500.00
Stand-pipe	300,000
Pier for stand-pipe	200,000

The City Council and Board of Control reserve the right to reject any or all proposals.

E. E. CALDERWOOD,
Prest. of Council.
WM. THOMPSON,
Prest. Board of Control.
C. B. ELLIOTT, City Clerk,
J. C. WEAVER, Secy. pro tem. Board of Control.
JOHN W. HILL, Consulting and Constructing Engineer, 35-36 Glenn Bldg., Cincinnati, O.
Greenville, Ohio, January 9th, 1893. 2-2t

AT AUCTION.

TWO LARGE

Holly-Gaskill Pumping Engines.

MASTER'S PEREMPTORY SALE.

Holly Mfg. Co., et al, vs. New Chester Water Co., et al., at the pumping station of the New Chester Water Co., at Chester, Pa., on

Saturday the 21st day of January, 1893, at 12 o'clock noon, without reserve.

The engines are the Gaskill crank and fly-wheel horizontal, compound condensing, high duty pumping engines, each having two 21-in. h.-p., two 42-in. l.-p., two double acting plunger pumps, 18½ ins. diameter, 36 ins. stroke. Capacity, 4,000,000 gallons under 200-ft. head. May be safely run in emergencies to 5,000,000 gallons capacity.

The engines will be sold separately, and with each the usual regulators, oilers, gages and other appliances upon it, and deliverable on the premises, and to be removed by the purchaser under the supervision of the Master. Also one donkey pump and a small amount of cast iron and wrought iron pipe.

Terms of sale: The purchaser of each engine to sign a memorandum of purchase at the time of sale and pay one thousand dollars in cash, and the balance at the time of the confirmation by the court of the sale.

The property can be seen at any time upon application to the Master, or to Mr. JOHN LOCKMAN, on the premises.

For further particulars apply to FRANK P. PRICHARD, Master.
Philadelphia, Pa.

Other proposals see pages XI, XII, XIX, XX.